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THE STATUS OF THE ATLANTIC SALMON STOCK OF THE HUMBER RIVER, NEWFOUNDLAND, 1995

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ABSTRACT

This is the sixth assessment of the Atlantic salmon stock of the Humber River. Indices of abundance are mark and recapture estimates of run size, angling catch and effort data and public consultations. Returns of small salmon in 1995 were the highest and large salmon were the second highest in six years of assessment which includesd two pre-moratoium years (1990 and 1991). Spawning escapements were above the conservation target in 1995 and in three out of four post-moratorium years compared to zero out of 12 pre-moratorium years since 1980. Spawners replaced themselves in three out of four post-moratorium years compared to only four out of 12 pre-moratorium years since 1980. Estimates of the total population size of salmon in pre-moratorium years, based on an assumed exploitation rate in the commercial fishery, indicate a significant decline since 1974. With the exception of 1995, the total population size of salmon on the Humber River during post-moratorium years has been among the lowest recorded.

The experience of anglers at public consultations in 1995 was that salmon were abundant on the river in the past season. Recreational catches of small salmon compiled by DFO in 1995 were above those in 1994 but below the 1992-1994 mean and below catches in pre-moratorium years. The interpretation of stock status based trends in recreational catch and effort data is confounded by the unknown effects of various catch and effort controls implemented in the fishery in recent years. In addition, as a result of less emphasis being placed on the collection of recreational catch data, the actual observed, as opposed to estimated, catches and effort reported in 1995 were only 35% of the total (observed + estimated) catch and effort compared to 80% in years prior to 1990. The results of creel surveys at Big Falls suggest that angling catches on the Humber River are being underestimated by as much as 50%.

The smolt age distribution of adult salmon on the river in 1994 and 1995 was approximately 50% age-3 and 50% age-4. Assuming that this distribution remains unchanged, it will not be until 1997 and 1998 for small salmon and 1998 and 1999 for large salmon that the potential will exist for increased recruitment back to the river as a result of the moratorium. The recruitment back to the Humber River in 1996, based on the mean recruit/spawner ratio in 1992-1995, is anticipated to be less than in 1995.

RÉSUMÉ

Nous présentons la sixième évaluation du stock de saumon atlantique de la rivière Humber. Les indices de l'abondance sont fournis par les estimations de l'effectif de la remonte par marquage-recapture, les données sur les prises et l'effort de la pêche à la ligne, et la consultation publique. Les retours de petits saumons de 1995 étaient les plus élevés, et ceux de grands saumons étaient les deuxièmes en importance de la période d'évaluation de six ans, qui couvrait deux années pré-moratoire (1990 et 1991).Les échappées de géniteurs étaient au-dessus de la cible de conservation en 1995 et pendant trois des quatre années après moratoire, contre zéro des douze années pré-moratoire, depuis 1980. On note un renouvellement des géniteurs pendant trois des quatre années post-moratoire, alors qu'il n'avait eu lieu que pendant quatre des douze années pré-moratoire depuis 1980. Les estimations de l'effectif total de la population avant le moratoire, d'après un taux d'exploitation supposé dans la pêche commerciale, indiquent une baisse nette depuis 1974. À l'exception de 1995, l'effectif total de la population de saumon de la Humber dans les années post-moratoire est le plus bas jamais enregistré.

Les pêcheurs sportifs consultés en 1995 ont signalé que les saumons étaient abondants dans la rivière au cours de la dernière saison. Les prises sportives de petits saumons, d'après les calculs effectués par le MPO en 1995, étaient supérieures à celles de 1994, mais inférieures à la moyenne de 1992-1994 et aux prises des années pré-moratoire. L'interprétation des tendances des prises et de l'effort de la pêche sportive par rapport à l'état du stock est compliquée par les effets inconnus de divers contrôles des prises et de l'effort mis en oeuvre dans la pêche ces dernières années. De plus, comme on accorde moins d'importance à la collecte de données sur la pêche sportive, les prises et l'effort réellement observés, au lieu d'être estimés, rapportés en 1995 correspondaient à seulement 35 % du total des prises et de l'effort (observations + estimations) contre 80 % dans les années antérieures à 1990. Les résultats de l'enquête sur la pêche sportive menée à Big Falls permettent de penser que les prises sportives sur la rivière Humber peuvent être sous-estimées de 50 %.

La distribution des âges de smoltification des saumons adultes de la rivière en 1994 et 1995 était d'environ 50 % d'âge - 3 et 50 % d'âge - 4. Si l'on pose que la distribution va rester identique, ce n'est pas avant 1997 et 1998 pour les petits saumons, et 1998 et 1999 pour les grands saumons, qu'on peut miser sur un accroissement du retour à la rivière par suite du moratoire. Le recrutement des saumons revenant à la rivière en 1996, d'après le rapport moyen recrue/géniteur de 1992-1995, semble devoir être inférieur à celui de 1995.

INTRODUCTION

The Humber River is the largest river flowing into the Bay of Islands, situated in western Newfoundland at the northern limit of Salmon Fishing Area (SFA) 13 (Fig. 1). The Humber River comprises 95% of the drainage area of the Bay of Islands (8124 km^2) which is 57% of the total drainage area of SFA 13 and flows into Humber Arm (Fig. 1) at latitude 48° 57' N and longitude 57° 53' W. The total length of all tributaries in the Humber River is 2450.5 km. Complete obstructions to migrations of anadromous Atlantic salmon within the river system occur at Main Falls (Fig. 2) which is 112.6 kilometres from the river mouth and at Junction Brook which was diverted for hydroelectric development in 1925. The diversion of Junction Brook which flowed into the Humber River at Deer Lake resulted in the loss to the Humber River system of the anadromous salmon production potential of the Grand Lake system (Porter et al., MS 1974) (see Fig. 2). No fish passage facility was provided during the diversion to maintain upstream migration of fish stocks.

The Humber River, on average, is the largest producer of Atlantic salmon recreational harvests in Newfoundland and Labrador. Commercial and recreational salmon fisheries management measures implemented in Newfoundland and Labrador since 1978 that would have helped to conserve this stock include:

1. 1978 - commercial season shortened to June 1-July 10 from May 15-December 31.
2. 1984 - mandatory release of large salmon (≥63 cm fork length) in recreational fishery.
3. 1987 - recreational season bag limit of 15 small salmon (<63 cm fork length).
4. 1990 - 35 t commercial quota in SFA 13 commercial fishery.
5. 1991 - 25 t commercial quota in SFA 13; recreational season bag limit of 10 small salmon.
6. 1992 - five year commercial moratorium; recreational quota of 5,000 small salmon in SFA 13 reached on 1 August; Adies Lake (Fig. 2) quota of 100 small salmon not reached; a catch and released fishery was permitted from 2 August to 7 September after the quota was reached; recreational season bag limit of eight small salmon.
7. 1993 - recreational quota of 5,200 small salmon in SFA 13 (4,160 for June 5-July 31 and 1,040 for Aug.1-Sept.6) not reached; Adies Lake closed 31 July - quota of 100 small salmon not reached; daily bag limit of one fish; Cook's Brook was closed for the season.
8. 1994 - recreational season bag limit of three small salmon before 31 July and three after 31 July; Adies Lake closed 31 July - quota of 100 small salmon not reached; daily bag limit of two fish; daily catch and release limit of four fish.
9. 1995 - recreational season bag limit of three small salmon before July 31 and 3 after July 31; Adies Lake closed 30 July - quota of 100 small salmon not reached; daily bag limit of two fish; daily catch and release limit of four fish.

This is the sixth assessment of the status of the Humber River salmon stock since 1990. In 1990 and 1991, the stock achieved 60% and 27%, respectively, of the target spawning requirement for the river (Chaput and Mullins MS 1991, 1992). In 1992, with the closure of the commercial salmon fishery and the implementation of effort controls in the recreational fishery, the spawning target was exceeded (117%). In 1993, the stock continued to show signs of improvement, achieving 96% of the target. However, returns of adult salmon to the river in 1994, achieved only 40% of the spawning target. The low spawning escapement in 1994, compared to 1992 and 1993, is attributed to extremely low spawning success in 1989. The progeny of spawners in 1989 would have produced most of the recruitment in 1994.

The present assessment of the Humber River salmon stock provides updated recreational catches and effort information for 1995 and estimated spawning escapements following the methodology presented for 1990-1994 (Chaput and Mullins, MS 1991; Chaput and Mullins, MS 1992; Mullins and Chaput, MS 1993; Mullins and Chaput, MS 1995; Mullins and Reddin, MS 1995). The following topics are addressed:

1) analysis of annual trends in recreational catches and effort
2) verification by independent creel method, of the recreational catch statistics collected by the Department of Fisheries and Oceans (DFO) for the Big Falls segment of the Humber River,
3) estimation of total returns and spawning escapements in 1995 based on the angling exploitation

rate on small salmon derived using mark-recapture methods and applied to the total recreational catch
4) updating of the biological characteristics of the Humber River Atlantic salmon stock for 1995,
5) examination of the effect of the 1995 management regulations on the spawning escapement to the Humber River,

MATERIALS AND METHODS

Recreational Fishery Statistics

The DFO catch statistics for the recreational fishery were compiled from river guardian and fisheries officer reports. The traditional methods used for summarizing these data are described in Mullins and Claytor (MS 1989) and Mullins et al. (MS 1989). Catch and effort for the Humber River are described by river segment (Fig. 1- 2) and the standardized weeks used are described in Table 2. Weekly salmon angling reports have also been completed for the catch and release fishery since 1992. Salmon catches in the recreational fishery are categorized into small (<63 cm) and large (≥63 cm) size groups.

Creel Survey at Big Falls

A creel survey to determine the angling catch at Big Falls was conducted between 17 June and 5 September 1995. The Big Falls segment of the Humber River (Fig. 2) was again selected for the survey because it is accessed by anglers from only two points and the average catch from this segment, based on DFO statistcs, has been 38% of the total Humber River catch since 1986.

A "bus route" design (Robson and Jones 1989; Chaput et al. MS 1992; Mullins and Chaput, 1993; Mullins and Chaput, MS 1995), in combination with lattice sampling (Robson, 1990), was used to obtain catch and effort data of anglers at the two access points (Appendix 1).

The sampling day was divided into four time periods: 0600-1000, 1000-1400, 1400-1800, and 1800-2200. Two time periods were sampled every census day. During each four-hour period sampled, the creel survey clerks interviewed anglers as they departed the fishing locations. The clerks recorded the number of hours fished by each angler, the number of salmon retained and released, and the number of carlin tagged salmon recaptured. Clerks were instructed to maintain records independent of those kept by DFO Guardians.

A stratum is a block of days treated as a unit. Weekly strata (seven days) were used at Big Falls in 1995. The number of time periods sampled within a stratum was dictated by the available resources. Sampling effort within strata consisted of five days per strata for the entire season. The days and the time periods within the day to be sampled were randomly selected within each stratum.

The total catch for each stratum (week) was obtained by weighting the observed sampling period matrix with the Horvitz-Thompson matrix which gives equal weight to the individual sampling periods within a stratum (Robson, 1990). The variance of the catch estimate was calculated for each stratum using the Yates-Grundy variance formulation (Robson, 1990). Totals and variance estimates of totals for combined strata were obtained by summation. The confidence intervals of the estimate were calculated using $\pm$ 2 standard deviations.

Estimation of Angling Exploitation Rate

Two tagging traps were operated in the estuary of the Humber River in 1995 (Fig. 1). Small and large salmon were marked with Carlin tags and released. Tags were applied using a double stainless steel wire attachment directly under the anterior end of the dorsal fin. All salmon captured in the two traps were measured (fork length 0.1 cm), and scale sampled.

Lower Trap - This trap has been fished in the same location at Wild Cove, Humber Arm (Fig. 1), since 1990. The trap design and installation in 1995 were identical to the 1990-1994 tagging program.

Upper Trap - This trap was fished about 1.5 km upstream from the Lower trap (the same location as in 1993). This trap had been fished approximately 10 km further upstream in 1994.

Injured fish were not tagged and no tagging was conducted at water temperatures above 20 C. Therefore, tagging mortality is believed to be negligible.

All salmon tagged in 1995 were assumed to be destined for the Humber River. However, tagged salmon have been recaptured in the past (2-12 in 1990-1993) from Hughes Brook which flows into the Humber Arm about 3.0 km north of the Humber River estuary. An adjustment for tags destined for Hughes Brook in 1995 would have increased the angling exploitation rate estimate by a maximum of 0.4%.

The angling exploitation rate (ER) on small salmon (retained) on Humber River in 1995 was based on the number of tags returned from retained small salmon, divided by the number of small salmon tagged at both tagging traps according to the formula:

ER = Tags Recaptured (TR) / Tags Available (TA)

where:

TR = Total Tags Returned / Reporting Rate (RR)
TA = Tags Applied x (1 - Tag-Loss Rate(0.009 x Median Days to Recapture))

and:

RR = Observed Tags Returned from Big Falls / Observed Tags Recaptured at Big Falls

The reporting rate (RR) or proportion of recaptured tags that were returned voluntarily by anglers in 1995 were estimated on the basis of recaptures observed by the creel survey clerks at Big Falls. Clerks were instructed to observe only and not to prompt anglers to return tags. Note: The ratio *(tags/catch at Big Falls):(tags/catch for the rest of the river)* does not give a valid estimate of the reporting rate because creel clerks did not observe 100% of the tags recaptured at Big Falls. Tags returned from small salmon that were unknown to be retained or released were apportioned into retained or released recaptures based on the relative proportions of known retained and released recaptures.

Tags available (TA) to anglers in 1995 were estimated from the number of tags applied to small salmon multiplied by the proportion of tags retained (1- Tag-Loss Rate) as in previous years. The tag-loss rate was estimated based on the proportion of 0.009 tags shed per day to recapture derived for Margaree River in 1992 (Chaput et al., MS 1993). The method of tag application to salmon in the Margaree River tagging program is the same as for the Humber River. Median days to recapture were determined according to (Sokal and Rohlf, 1969). However, it is noted that five Humber River small salmon tagged on 27-28 July 1995 and held in captivity until 23 November, had 0.0% tag-loss at the time of release, 119 days after being tagged.

Tags available to the retention fishery were not adjusted for tags returned from released small salmon as these fish would also have been available to retention angling for a period of time before recapture. If the number of tags returned from released fish had been adjusted for the period of time they were available to the retention fishery and excluded from the total number of tags available, the exploitation rate calculation would have increased by less than 1.5%.

Estimation of Returns to the Humber River

The total recreational catch of small salmon retained on the Humber River was estimated based on the catch of small salmon recorded by the creel survey clerks at Big Falls and the proportion of tag returns recaptured by angling at Big Falls.

Adjusted Catch (AC) = Catch at Big Falls (Creel) / Proportion Tags at Big Falls

In previous assessments the proportion of the total river harvest angled at Big Falls was estimated by two methods: 1. the proportion of catch reported from Big Falls in the DFO catch statistics and 2. the proportion of tags returned from Big Falls. In 1995, only the tags method was used.

Catches of small salmon recorded by the creel survey clerks at Big Falls were from immediately below (1-2 km) the falls area and did not include the pools further downstream (Mistaken Point area) which were accessed via another route, but which would have been included in the DFO catch statistics for the Big Falls segment (Fig. 3). As a result the catch recorded by the creel survey clerks at the falls was adjusted to give a catch for the entire Big Falls segment. This was done based on the proportion of Big Falls tags recaptured at the falls area.

The number of small salmon that returned to the Humber River in 1995 was estimated by two methods based on total adjusted catch of small salmon retained, adjusted tags available to angling, and adjusted recaptures:

1. Petersen (Single Census) method (Ricker, 1975) according to the formula:

Returns of Small (RS) = AC / ER

2. maximum-likelihood stratified design following the method of Dempson and Stansbury (1991) and Darroch (1961).

For the maximum-likelihood estimate, the number of tags released and tags recaptured were initially stratified into six release and seven recapture intervals of two weeks each. The original matrix was collapsed to reduce the number of intervals with zero releases or recaptures.

The number of large salmon on the Humber River in 1995 was estimated by applying the ratio of large to small salmon captured in the two tagging traps to the estimate of small salmon returns where:

Returns of Large (RL) = RS x (Ratio of Large:Small at Tagging Traps)

In the 1990 and 1991 assessments, the appropriate ratio of large to small salmon returns to the river was considered to be equivalent to the ratio of large to small salmon in the recreational fishery prior to 1984 (7%) when large salmon could be retained (Chaput and Mullins, MS 1991, 1992). However, a commercial fishery was also permitted in these years. Because of the closure of the commercial fishery in 1992 and the potential for an increase in the river escapement of large salmon, the ratio of large to small salmon captured at the tagging traps is considered to be more representative of returns to the river in 1995.

Biological Characteristics

Biological characteristics of Humber River salmon in 1995 were obtained from bright salmon at the tagging traps and from angling catches at the Big Falls segment of the Humber River. The fish were sampled for fork length (0.1 cm) and whole weight (0.1 kg) and sex determination which was by internal examination except on live fish. Scale samples were obtained for determining the river-age and sea-age. These methods were identical to those used in 1990-1994.

Estimation of Potential Egg Depositions

The potential egg depositions were calculated using the estimated spawning escapement and observed biological characteristics (mean weight of females, percent female, fecundity) of small and large salmon in 1995. The spawning escapement was obtained by subtracting the adjusted total recreational catch of small salmon retained from the estimated returns to the river.

The target egg deposition requirement for the Humber River was calculated using an optimal egg deposition for fluvial and lacustrine parr rearing area (Mullins and Chaput, MS 1995). The egg deposition rate used for fluvial area was 2.4 eggs/m^2 as described by Porter and Chadwick (MS 1983) and the egg deposition rate used for lacustrine area was 368 eggs/ha as described by O'Connell et al. (MS 1991).

Number of Recruits and Spawners, 1974-95, and Anticipated Returns in 1996

O'Connell, et al. (1995) described a technique whereby it was possible to retrospectively construct total population size of small salmon (or total number of small salmon recruits) prior to any exploitation in selected rivers with counting facilities and to use the number of salmon recruits per spawner to estimate anticipated returns one year in advance. The technique is fully described in O'Connell, et al. (1995) and equations used to derive recruits and spawners for the Humber River salmon stock are the same with the exception that large salmon are included (exploitation rate in commercial fishery = 0.80) and that estimated small and large recruits have been weighted by the mean proportion of virgin 1SW and 2SW salmon in 1989-1995. However, spawning escapements are based on both virgin and repeat spawners.

Analysis to Detect Recruitment Overfishing

Details on analysis to detect recruitment overfishing are provided by O'Connell, et al. (1995). Spawning escapements which produced total small and large salmon spawners on the Humber River in 1980-1995 were constructed by weighting previous spawning escapements by the smolt age distribution of 1SW salmon on the Humber River in 1993.

RESULTS

Recreational Effort and Catches

The recreational angling season on the Humber River opened on 3 June and closed on 4 September 1995. The Adies Lake quota of 100 small salmon was not reached but this segment closed to fishing on 30 July. The opening and closing dates and bag limits were essentially the same as in 1994.

The catch of small salmon retained on the Humber River in 1995, according to DFO catch statistics, was 1,825 fish, which was approximately 18% above the catch reported in 1994, but it was 9% below the 1992-1994 mean (Fig. 4) and 29% below the 1987-1991 mean (Table 4). Retained and released catches in 1995, similar to retained catches, were above those in 1994, but unlike retained catches, were 5% above the 1992-1994 mean (Table 4). This may be due to an increase in the proportion of small salmon hooked and released in 1995 compared to previous years.

Released catches of small salmon in 1995, were 52% above those in 1994 and 28% of the total retained and released catches in 1995 up from 23% in 1994 (Table 4). Released catches were reported to be 21% of the total in 1993 and only 8% of the total in 1992. Released catches of large salmon in 1995 were 40% above those in 1994 and 49% above the 1992-1994 mean (Table 4).

Angling effort in 1995, similar to catches, was 21% above the effort in 1994, 10% above the 1992-1994 mean

and similar to the 1987-1991 mean and 12% below the effort in 1977-1986 (Table 4).

The highest angling effort reported in 1995 was at Big Falls followed by Harrimans Steady and the Lower Humber River. However, the effort on the Lower Humber peaked in week 32 compared to weeks 26-27 at Harrimans Steady and Big Falls. Effort in the Lower Humber was directly primarily at large salmon and produced the highest catches of large salmon on the river (93) in 1995.

The highest catches of small salmon retained were at Big Falls (549) and Harrimans Steady (514). The catch of small salmon retained at Big Falls was 30% of the Humber River catch in 1995 compared to 42% in 1994, 40% in 1993, 63% in 1992, and an average of 40% in 1984-1992.

The catch-per-unit-effort (CPUE) of small and large salmon retained and released on the river in 1995 was no higher (within 10%) than in 1994 or the mean since 1977 (Table 4).

The actual observed effort and catch recorded in the DFO catch statistics in 1995 accounted for only 35% of the total observed and estimated effort and catch (Table 5). This compares with 30% in 1994 (Mullins and Reddin, 1995) but is much lower than the 80% observed reported in years prior to 1990 (Mullins and Claytor 1989).

Creel Survey Catches at Big Falls

A total of 1,244 anglers were interviewed or observed by the creel survey clerk located at Big Falls in 1995 (Table 6). Anglers fished for an average of 3.80 hours which was similar to the effort expended in 1994 and 1993, but 14% below effort in 1992. The total catch observed was 375 small salmon retained and 137 released, and 17 large salmon released. The catch of small salmon retained per unit of effort (CPUE) for interviewed anglers was the highest in the last three years that the survey was conducted.

The creel survey estimate of small salmon retained at Big Falls in 1995 was 1,853 (CI=1,639-2,068) which was more than three times the DFO estimate of 549 (Table 7a). The distribution of retained catches estimated by the creel survey and the DFO methods were quite similar, with the exception of week 3 (July 1-7), which was the week of peak catches for both methods (Fig. 5). The creel survey estimate of small salmon released at Big Falls was 678 (CI=512-844) which was more than five times the DFO estimate of 127 (Table 7b) but the weekly distribution of released catches was similar for both methods (Fig. 6). The creel survey estimate of large salmon released was 104 (CI=36-172) compared to the DFO estimate of 47 (Table 7c). The distribution of large salmon released was similar for both methods and the week of peak catches occurred one week earlier than catchesof small salmon retained or released (Fig. 7). The amount of angling effort could not be directly compared between the two methods because the angling effort recorded by DFO was in rod days and the creel effort was in hours fished. However, as for catches, the distribution of weekly angling effort was similar for the two methods but with less difference between the two during the peak week (Table 7d; Fig. 8).

Estimation of Angling Exploitation Rate

The Lower estuarial tagging trap was operated from 7 June to 18 September and the Upper Trap was operated from 2 June to 31 August 1995. A total of 145 large and 1960 small bright salmon were captured in both traps (Table 8). The ratio of large:small salmon captured in 1995 was 0.0740:1 which was 42% below the ratio of large:small salmon in 1994 and 110% above 1993.

The distribution of catches was earlier for the tagging trap located further downstream. Peak catches of small salmon occurred in late June in both traps (Fig. 8a-b). However, the majority of catches in the Lower trap occurred in early June while those in the Upper trap occurred in early July. The peak catches of large salmon in the Lower trap occurred in early June but later in June and in July in the Upper trap.

In general, tag releases from the Lower trap peaked two weeks earlier than in the Upper trap (Table 9; Fig. 9). A total of 1,912 (821 Lower and 1,091 Upper) small bright salmon and 136 (99 Lower and 37 Upper) large salmon were tagged and released from the two traps (Tables 9, 10). Tagging was not carried out at surface water temperatures above 20 C and the number of tags returned did not appear to be related to the water temperature at the time of tagging (Table 11).

Recaptures from angling of salmon tagged in the Lower trap were about one week earlier than salmon tagged in the Upper trap (Fig 10). However, the distribution of recaptures from the two traps combined, was similar to the distribution of angling catches for small salmon (Fig. 11) indicating that tagged fish from both traps were evenly dispersed in the population and available to the fishery at the same time as untagged fish.

Tagged small salmon were recaptured on all major segments of the Humber River (Table 12). The largest number were recaptured at Big Falls (104) and Harrimans Steady (55). A total of 236 recaptured tags was returned from retained and released small salmon and six from released large salmon (Table 13).

The median number of days at large before recapture of tagged small salmon was 13.4 days (Table 14). This was similar to the mean number of days at large for tagged salmon in 1993 and 1994. The minimum was zero days and the maximum was 71 days. The estimated overall proportion of tags retained in this period were 0.880 (1-(0.009 x 18 days)).

Out of a total of 23 Carlin tags which were removed from angled (retained and released) small salmon and observed by four creel survey clerks located on different sections of the Humber River in 1995 (Table 6), 60.87% were (14) subsequently returned voluntarily by the anglers. This is similar to the repoting rate of 0.64 estimated in 1994 (Mullins and Reddin, MS 1995) and the rate of 0.75 which was assumed for the Humber River assessment in 1993.

After adjustment for tag loss and reporting rate, the angling exploitation rate for 1995 was 0.1846 (Table 14). This was the lowest rate in six years of assessment (0.25 in 1990-1991; 0.22 in 1992; 0.2213 in 1993; and 0.2865 in 1994). Angling exploitation was highest on salmon tagged and released early in the run (week 24-25) and ranged from 0.16-0.25 throughout (Table 14). The range of exploitation rates indicates that, to some extent, the fishery harvested certain portions of the salmon run more than others. However, in general, the difference in exploitation rates between the various two week periods of tagging was relatively low. Therefore, it is expected that a stratified estimate of the population by two week intervals would not yield a significantly different estimate than an overall estimate based on the average exploitation rate for the season.

Biological Characteristics

Small salmon captured in the tagging traps and in angling on the Humber River in 1995 were primarily (99%) virgin one-sea-winter (1SW), whereas, large salmon were primarily (55%) repeat spawning grilse which was comparable to previous years (Table 15a-b). The average sea age composition of Humber River salmon in 1989-1995 is 96.9% 1SW for small and 42.4% 2SW for large.

The mean weight of small female salmon sampled in the recreational fishery in 1995 was 1.60 kg (N=18) and the sex composition was 51.4% female (N=72) (Table 16a-b). For the second consecutive year the smolt-age distribution of angled and tagged virgin 1SW salmon was divided almost equally between age-3 and age-4 smolts (Table 19). In 1995, 47% were smolt-age-3, and 52% were age-4 (Table 17a-b). Prior to 1994 the predominant smolt age-class was three years. This was similar to the smolt-age of virgin 2SW salmon in 1995 but in 1994 smolt-age-3 was the predominant age-class of 2SWs (Table 17).

Returns and Escapements to the Humber River.

The adjusted catch of small salmon retained at Big Falls was 2,534 (95% CI=2,386-2,669) and the adjusted catch of small salmon retained on the whole river was 5,150 (95% CI=4,799-5,557) (Table 18). On the basis of the adjusted number of tagged small salmon available to angling and the adjusted number of tags returned by anglers, the Petersen (single census) method estimated that 27,898 (95% CI = 25,001 - 31,232) small salmon returned to the river in 1995 (Table 19). Based on the ratio of large:small salmon caught in the tagging traps, 2,064 (95% CI=1,757 - 2,360) large salmon also entered the river in 1995 (Table 19).

The Darroch maximum-likelihood stratified estimate of small salmon abundance in 1995 was 27,254 (95% CI=24,428-30,080) which was less than 5% below the Petersen estimate (Table 19).

The potential spawning escapement on the Humber River in 1995 was 22,748 small and 2,064 large salmon. Both of these stock components were above their respective target spawner requirements (Fig. 12).

These spawning escapements of small and large salmon in 1995 would have resulted in an egg deposition which was 129% of the target egg deposition requirement (Table 20). This was the largest spawning escapement of small salmon and the second largest escapement of large salmon spawners achieved since the closure of the commercial salmon fishery in 1992 (Table 21).

Number of Recruits and Spawners, 1974-95, and Anticipated Returns in 1996

The outcome of calculations of total numbers of salmon recruits, numbers of spawners, and numbers of recruits per spawner are shown in Figs 12-13. There was a lot of variability in recruitment from a given spawning escapement (Fig. 13a). Since 1974, there was a significant decline (r^2=0.40; df = 19; P<0.01) in the total number of small and large salmon recruits for Humber River (Fig. 13d). Except for 1990, the lowest recruitment for the entire time series was experienced during the period 1989-1994. In fact, 1994 was the lowest. This trend appears to have been broken with the higher recruitment in 1995.

There was no identifiable trend in the total number of small and large spawners (Fig. 12c). Expressing target spawning requirements in terms of salmon adults (horizontal line in Fig. 12c), it is evident that target spawners were achieved in 1975-1976 and 1992-1993. Numbers of spawners in 1992-94 although declining over that period compare well with higher values in the past, particularly the late 1970s and early 1980s, and represent a substantial improvement over the lows observed for 1989 and 1991. Spawners in 1995 were the highest recorded.

The total number of salmon recruits produced per spawner showed no trend for small salmon (r^2=0.13; df = 14; P>0.05) (Fig. 13b) but declined significantly for large salmon (r^2=0.60; df = 13; P<0.01) (Fig. 13c). The number of small and large salmon recruits anticipated for 1996, based on the average number of small and large recruits produced per spawner for each river age grouping in 1993-1995, is approximately 15,710 small and large salmon.

Given a similar smolt-age distribution of 1SW salmon in 1996 to those in 1995, returns of 1SW salmon in 1996 will be influenced by the relatively high spawning escapement in 1990 and the relatively low escapement in 1991. The returns of 2SW salmon in 1996, assuming a similar smolt-age distribution to those in 1995, will be influenced by the spawning escapements in 1989 and 1990 that produced the relatively high returns of 1SWs in 1995 (Fig. 14).

Analysis to Detect Recruitment Overfishing

Since the closure of the commercial salmon fishery (1992-1995), the number of spawners on Humber River has been above estimates of their cohorts derived by weighting previous spawners by the smolt-age distribution of their progeny (Fig. 14). Spawners in 1992-1995 have been above the replacement (diagonal) line (Fig. 15). In two of the three years immediately preceding the moratorium, 1989 and 1991, numbers of spawners were well below the replacement line. Of the total number of 16 data points, eight were below.

DISCUSSION

Recreational catches of small salmon compiled by DFO on the Humber River in 1995 increased in comparison to 1994 but not to the 1992-1994 mean or to pre-moratorium years.

The interpretation of annual trends in recreational catch and effort data is confounded by the unknown effect of the various catch and effort controls which have been implemented in the recreational fishery in recent years and have succeeded in keeping catches at a low level compared to historical levels. In addition, discrepancies exist between catch data reported by DFO at Big Falls on the Humber River and those based on creel survey results which suggest that total catches may be underestimated in the DFO catch statistics by as much as 50%. This is not surprising given that the proportion of catches and effort actually observed, as opposed to estimated, by the DFO river guardians in recent years has declined. In 1995, actual observed catches and effort accounted for only 35% of the total (observed + estimated) catches and effort. This was similar to 1994 when 30% of the total catches were actually observed (Mullins and Reddin, 1995) but was much lower than years prior to 1990 when 80% of the total catches were actually observed (Mullins and Claytor 1989). In 1991 and 1994, when catches on the Humber River were at their lowest level in recent years, there was little difference between the DFO and creel survey results. In contrast, it appears that in 1992, 1993 and 1995, when angling catches were higher, the greatest discrepancy occurred between the two estimates of catch at Big Falls. It appears that it is more difficult to obtain an accurate estimate of the catch by the traditional methods when catches are high than when catches are low. If this is true for other rivers then population sizes derived from angling catch statistics will be underestimated on these rivers.

The high effort on the Lower segment of the Humber River in 1995 and 1994 compared to the 1992-1993 mean was probably due to the increase in catches of large salmon on this section of the river indicating an increase in the abundance of large salmon.

The Petersen single census and Darroch (1961) stratified estimates of small salmon returns to the Humber River in 1995 were almost identical. While, there was some variation in recapture probabilities among the two recapture strata of the Darroch (Appendix 2), the mean of the Darroch recapture probabilities (0.19) was very similar to the overall angling exploitation rate (0.18). This was the result of pooling of several of the initial strata which was necessary for the Darroch estimator as a result of low numbers of tag recaptures in some strata. If the number of recaptures had been large enough to maintain the initial number of strata, the Darroch stratified estimate of small salmon returns would probably have been a more appropriate estimator than the single census estimate in 1995.

The increase in total spawning escapement on the Humber River in 1995 compared to 1994 was anticipated as a result of the increased spawning escapement in 1990 compared to 1989. However, the magnitude of the increase was much greater than the maximum value anticipated (Mullins and Reddin, 1995). This can be attributed to an increase in the smolt-adult survival in 1995. However, it may also be a function of the variability in the recruit to spawner relationship.

The current assessment of the status of the Humber River salmon stock is based on returns to the river in June-August. While returns in June-August represent by far the majority, there is anecdotal evidence that a run of large salmon enters the river in the fall. There has been some discussion among angling organizations in recent months about a fall fishery on this stock component given that the status of the Humber stock in general appears to have improved.

The following points need to be kept in mind in this discussion:

1. Compared to estimates of the total salmon population size in pre-moratorium years, based on an assumed exploitation rate in the commercial fishery, returns to the river in post-moratorium years are still far below historical levels.
2. Based on the smolt age distribution of approximately 50% age-3 and 50% age-4 of adults sampled in 1994 and 1995, small salmon recruits from the first post-moratorium year-class (1992) will not return to the Humber River until 1997 and 1998 and large salmon recruits will not return until 1998 and 1999.
2. We have little or no information on either the abundance or the biology of salmon entering the Humber River in the fall. If the popular assumption is correct that these fish are primarily virgin large salmon, then they are indeed a unique stock component because large salmon that enter the Humber River in June-August are primarily repeat spawners.

Assuming similar angling exploitation in 1996 to that in 1995, the spawning escapement anticipated for 1996, based on trend analysis, will be below the target. However, with the high variability in recruitment already described, the spawning escapement in 1996 may be even higher than in 1995. Recruitment in 1995 was 77% above that anticipated based on the ratio of recruits to spawners in 1992-1994.

In a stock with a healthy spawning population it is suggested that points in the spawner-recruit relationship described in Fig. 15 should fall above and below the line in a 50:50 distribution. Also, the points should fall above the target spawning line which in the case of the Humber occurred in three years of four years (1992, 1993 and 1995) since the closure of the commercial salmon fishery. We conclude from this that the Humber River salmon stock, while being below target spawning in some years, is now in a position to increase in size.

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REFERENCES

Chaput, G. and C. Mullins. MS 1991. The status of the Atlantic salmon stock of Humber River/Bay of Islands Newfoundland, 1990. CAFSAC Res. Doc. 91/14. 28p.

Chaput, G. and C. Mullins. MS 1992. The status of the Atlantic salmon stock of Humber River/Bay of Islands Newfoundland, 1991. CAFSAC Res. Doc. 92/28. 34p.

Chaput G., R Jones and C. C. Mullins. MS 1992. A practical assessment of bus route creel surveys and lattice sampling design for estimating the recreational catch of Atlantic salmon. CAFSAC Working Paper 92/16.

Chaput, G., R. Jones, L. Forsythe and P. Leblanc. MS 1993. Assessment of Atlantic salmon in the Margaree River, Nova Scotia, 1993. CAFSAC Res. Doc. 93/ 38p.

Darroch, J.N. 1961. The two-sample capture-recapture census when tagging and sampling are stratified. Biometrika 48:241-260.

Dempson, J.B. and D.E. Stansbury. 1991. Using partial counting fences and a two-sample stratified design for mark-recapture estimation of an Atlantic salmon smolt production. North American Journal of Fisheries Management 11: 27-37.

Hare Fisheries and Environmental Consultants. 1990. A strategy for enhancing and managing the Atlantic salmon resource in the Bay of Islands - Humber River ecosystem. Prepared for the Salmon Preservation Association for the waters of Newfoundland (SPAWN). 53p.

Mullins, C.C. and R.R. Claytor. MS 1989. Recreational Atlantic salmon catch, 1987 and 1988, and annual summaries, 1973-1988, for West Newfoundland and South Labrador, Gulf Region. Can. Data Rep. Fish. Aquat. Sci. No. 748. 192p.

Mullins, C.C. and G. Chaput. MS 1993. The Status of the Atlantic Salmon Stock of Humber River/Bay of Islands, Newfoundland, 1992. DFO Atl. Fish. Res. Doc. 93/34, 53 p.

Mullins, C.C. and G. Chaput. MS 1995. The Status of the Atlantic Salmon Stock of Humber River/Bay of Islands, Newfoundland, 1993. DFO Atl. Fish. Res. Doc. 95/84, 48 p.

Mullins, C.C. and D.G. Reddin. MS 1995. The Status of the Atlantic Salmon Stock of Humber River/Bay of Islands, Newfoundland, 1994. DFO Atl. Fish. Res. Doc. 95/115, 59 p.

Mullins, C.C., J.A. Wright, and R.R. Claytor. MS 1989. Recreational Atlantic salmon catch, 1986 and annual summaries, 1953-1986 for West Newfoundland and South Labrador, Gulf Region. Can. Data Rep. Fish. Aquat. Sci. No. 715. 124p.

O'Connell, M.F., J.B. Dempson, and R.J. Gibson. MS 1991. Atlantic salmon (Salmo salar L.) smolt production parameter values for fluvial and lacustrine habitats in insular Newfoundland. CAFSAC Res. Doc. 91/19. 11 p.

O'Connell, M.F., D.G. Reddin, and E.G.M. Ash. MS 1995. Status of Atlantic Salmon (*Salmo salar* L.) In Gander River, Notre Dame Bay (SFA 4), Newfoundland, 1994. DFO Atl. Fish. Res. Doc. 95/123 25 p.

Porter, T.R. and E.M.P. Chadwick. MS 1983. Assessment of Atlantic salmon stocks in statistical areas K and L, western Newfoundland, 1982. CAFSAC Res. Doc. 83/87. 86p.

Porter, T.R., L.G. Riche, and G.R. Traverse. MS 1974. Catalogue of rivers in Insular Newfoundland Volume C. Data Record Series No. NEW/D-74-9.

Ricker, W.E. 1975. Computation and Interpretation of Biological Statistics of Fish Populations. Bull. Fish. Res. Board Can. 191:382 p.

Robson, D. 1990. Handout on multi-dimensional lattice sampling in creel surveys. Manuscript 8p. (Available from D. Robson 150 McClaren, Ph 6, Ottawa, Ontario K2P 0L2, Canada).

Robson, D. and C.M. Jones. 1989. The theoretical basis of an access site angler survey design. Biometrics 45:83-98.

Sokal, R.R., and F.J. Rohlf. 1969. Biometry. W.H. Freeman and Company, 776 p.

Table 1. Week periods used to summarize Creel Survey Data.

Creel Week	Dates
1	June 17 - 23
2	June 24 - 30
3	July 1 - 7
4	July 8 - 14
5	July 15 - 21
6	July 22 - 28
7	July 29 - August 4
8	August 5 - 11
9	August 12 - 18
10	August 19 - 25
11	August 26 - September 1
12	September 2 - September 8

Table 2. Standardized weeks used to summarize angling data.

Week	Dates
22	May 28 - June 3
23	June 4 - 10
24	June 11 -17
25	June 18 - 24
26	June 25 - July1
27	July 2 - 8
28	July 9 - 15
29	July16 - 22
30	July 23 - 29
31	July 30 - August 5
32	August 6 - 12
33	August 13- 19
34	August 20 - 26
35	August 27 - Sept. 2
36	Sept. 3 - 9
37	Sept. 10 - 16
38	Sept. 17 - 23
39	Sept. 24 - 30
40	Oct. 1 - 7

Table 3. Equations used in estimation of angling exploitation rate, total catch and total returns of Atlantic salmon to the Humber River, 1995. Parameters in bold type changed values with each iteration of the simulation procedure.

1. EXPLOITATION RATE	=	Tags Recaptured / Tags Available
Tags Recaptured	=	Tags Returned / Reporting Rate
Reporting Rate	=	**Tags Returned from Big Falls** / **Tags Recaptured at Big Falls** = 14 / 23 = 0.6087
Tags Available	=	Tags Applied x Proportion Tags Retained
Proportion Tags Retained	=	1 - (Tag Loss Rate (TL)) TL = (0.009 tags/day x Median Days to Recapture) **Range of Days to Recapture = 0 to 71 days; Median = 13.4**
2. CATCH	=	Adjusted Catch at Big Falls / Proportion of Tags/Catch from Big Falls **(Proportion tags from Big Falls, 1995 = 93/189 = 0.49 21)**
Adjusted Catch at Big Falls (Small)	=	Creel Survey Catch from Falls Area / Proportion of Tags Recaptured from Falls Area **(Proportion tags from Big Falls Area, 1995 = 68/93 = 0.7312)**
3. RETURNS (Small) (Petersen single census)	=	CATCH (Small) / EXPLOITATION RATE
RETURNS (Large)	=	RETURNS (Small) Ratio Large:Small in Trapnets **(Ratio Large:Small = 145/1960 = 0.0740)**

The equations were solved 5000 times to generate the distribution from which confidence limits were determined.

Table 4. Recreational effort and catch on the Humber River 1953-1995.

Year	Effort (Rod days)	Small salmon Retained	Released	Total	Large salmon Retained	Released	Total	CPUE
53	3715	1260	.	1260	149	.	149	0.38
54	4161	876	.	876	137	.	137	0.24
55	2177	1376	.	1376	138	.	138	0.70
56	6953	1076	.	1076	110	.	110	0.17
57	2637	1778	.	1778	89	.	89	0.71
58	3350	1686	.	1686	194	.	194	0.56
59	3681	1996	.	1996	187	.	187	0.59
60	3511	1938	.	1938	178	.	178	0.60
61	3639	1867	.	1867	134	.	134	0.55
62	4017	2390	.	2390	108	.	108	0.62
63	5348	3898	.	3898	160	.	160	0.76
64	7222	4681	.	4681	268	.	268	0.69
65	6551	3951	.	3951	193	.	193	0.63
66	8842	3989	.	3989	322	.	322	0.49
67	5317	2252	.	2252	160	.	160	0.45
68	5104	2168	.	2168	96	.	96	0.44
69	9690	4459	.	4459	478	.	478	0.51
70	11785	2785	.	2785	526	.	526	0.28
71	9027	3949	.	3949	375	.	375	0.48
72	9413	3961	.	3961	219	.	219	0.44
73	9612	3411	.	3411	304	.	304	0.39
74	8976	2742	.	2742	107	.	107	0.32
75	9611	6147	.	6147	114	.	114	0.65
76	10489	5102	.	5102	61	.	61	0.49
77	6127	2158	.	2158	45	.	45	0.36
78	7633	2722	.	2722	187	.	187	0.38
79	7961	3343	.	3343	27	.	27	0.42
80	8292	3512	.	3512	303	.	303	0.46
81	8701	4132	.	4132	153	.	153	0.49
82	8737	4287	.	4287	95	.	95	0.50
83	7746	3110	.	3110	47	.	47	0.41
84	7189	2872	.	2872	40	.	40	0.41
85	7211	2430	.	2430	.	11	11	0.34
86	8635	3456	.	3456	.	261	261	0.43
87	7250	3074	.	3074	.	113	113	0.44
88	8521	4042	.	4042	.	144	144	0.49
89	6014	1217	.	1217	.	10	10	0.20
90	7008	3054	.	3054	.	75	75	0.45
91	5770	1431	.	1431	.	11	11	0.25
92	6072	2234	194	2428	.	177	177	0.43
93	7023	2206	601	2807	.	125	125	0.42
94	5687	1550	463	2013	.	166	166	0.38
95	6855	1825	705	2530	.	233	233	0.40
Mean:								
1992-1994	6261	1997	419	2416	.	156	156	0.41
1987-1991	6913	2564	.	2564	.	71	71	0.37
1977-1986	7823	3202	.	3202	90	.	117	0.42
% Change in 1995 from:								
1992-1994	9.5	-8.6	68.1	4.7	.	49.4	49.4	-1.7
1987-1991	-0.8	-28.8	.	-1.3	.	230.0	230.0	10.1
1977-1986	-12.4	-43.0	.	-21.0	.	.	99.3	-4.0

Table 5. Weekly observed and estimated recreational catches and effort (DFO) of Atlantic salmon on the Humber River, 1995.

Standard Week	Effort (Rod-days)			Small Salmon							Large Salmon		
				Retained			Released			Total	Released		
	Obs.	Est.	Total	Obs.	Est.	Total	Obs.	Est.	Total	Small	Obs.	Est.	Total
23	9	10	19	1	1	2	0	0	0	2	0	0	0
24	14	40	54	0	1	1	1	3	4	5	0	2	2
25	152	356	508	29	112	141	18	45	63	204	0	36	36
26	445	518	963	116	192	308	58	78	136	444	7	41	48
27	394	598	992	115	152	267	85	90	175	442	3	26	29
28	245	521	766	65	148	213	40	47	87	300	0	15	15
29	249	460	709	71	128	199	40	63	103	302	0	22	22
30	210	443	653	63	131	194	24	42	66	260	0	11	11
31	244	335	579	55	87	142	17	16	33	175	1	14	15
32	171	267	438	39	49	88	7	10	17	105	2	11	13
33	152	279	431	35	75	110	1	9	10	120	1	15	16
34	162	250	412	25	63	88	0	5	5	93	1	12	13
35	96	172	268	19	40	59	0	5	5	64	0	11	11
36	6	53	59	2	11	13	0	2	2	15	0	2	2
Total	2549	4302	6851	635	1190	1825	291	415	706	2531	15	218	233
Percentage of Total	37.2	62.8	100.0	34.8	65.2	100.0	41.2	58.8	100.0		6.4	93.6	100.0

Table 6. Summary of Creel survey observations at Big Falls, 1995.

Creel Week	Number Anglers Interviewed	Effort (hours)	Mean Effort per Angler (hours)	Number Small Salmon Retained	Number Small Salmon Released	Number Small Salmon Total	Number Large Salmon Released	Total Catch	CPUE*	Number Carlin Tags Observed
1	75	301	4.0	31	7	38	7	45	0.15	0
2	200	731	3.7	72	33	105	7	112	0.15	3
3	308	1222	4.0	106	58	164	1	165	0.14	5
4	193	735	3.8	57	18	75	0	75	0.10	3
5	139	530	3.8	44	11	55	2	57	0.11	2
6	109	444	4.1	28	5	33	0	33	0.07	0
7	81	301	3.7	15	3	18	0	18	0.06	3
8	50	145	2.9	1	0	1	0	1	0.01	0
9	30	112	3.7	4	1	5	0	5	0.04	0
10	21	72	3.4	3	1	4	0	4	0.06	0
11	38	173	4.6	14	0	14	0	14	0.08	0
Total	1244	4766	3.8	375	137	512	17	529	0.11	16
1994 Values **	3839	14219	3.7	765	436	1201	63	1264	0.09	14
1993 Values	1613	6031	3.7	412	30	442	20	462	0.08	2
1992 Values***	607	2628	4.3	738	59	797	25	822	0.31	5
1991 Values	726	1600	2.2	136	.	136	.	.	0.09	.

* CPUE based on total catch except for 1991 (retained small salmon only in 1991) and 1992 (only anglers with catch interviewed in 1992).

** 1994 values represent the entire catch and effort at Big Falls.

*** Only anglers with catch interviewed in 1992.

Table 7a. Retained catches of small salmon estimated by DFO catch statistics and creel survey methods at Big Falls, Humber River, 1995.

	Small salmon (retained)								
	DFO		Creel						
Week	Estimate	% of Total	Estimate	% of Total	Variance	Std.Dev.	Lower C.I.	Upper C.I.	Coef. Var.
1	26	4.7	160	8.6	552	23.5	113	206	.
2	107	19.5	381	20.6	1,680	41.0	299	463	10.8%
3	109	19.9	524	28.3	2,219	47.1	429	618	9.0%
4	87	15.8	254	13.7	1,504	38.8	177	332	15.3%
5	55	10.0	216	11.6	1,497	38.7	138	293	17.9%
6	56	10.2	131	7.1	548	23.4	84	178	17.9%
7	38	6.9	104	5.6	2,861	53.5	-3	211	51.5%
8	17	3.1	4	0.2	12	3.5	-3	11	91.2%
9	17	3.1	15	0.8	115	10.7	-6	37	69.6%
10	22	4.0	12	0.6	59	7.7	-4	27	66.8%
11	15	2.7	54	2.9	449	21.2	12	96	39.3%
12	0	0.0	0	0.0	.	.	.	.	.
Total	549	100.0	1,853	100.0	11,496	107.2	1,639	2,068	5.8%

Table 7b. Released catches of small salmon estimated by DFO catch statistics and creel survey methods at Big Falls, Humber River, 1995.

	Small salmon (released)								
	DFO		Creel						
Week	Estimate	% of Total	Estimate	% of Total	Variance	Std.Dev.	Lower C.I.	Upper C.I.	Coef. Var.
.	1	0.8							
1	19	15.0	28	4.1	310	17.6	-8	63	64.0%
2	33	26.0	173	25.6	1,529	39.1	95	252	22.6%
3	37	29.1	293	43.1	2,904	53.9	185	400	18.4%
4	13	10.2	69	10.2	264	16.2	37	102	23.4%
5	8	6.3	42	6.2	220	14.8	13	72	35.1%
6	6	4.7	19	2.8	18	4.2	11	28	22.0%
7	6	4.7	46	6.8	1,658	40.7	-35	128	88.1%
8	2	1.6	0	0.0	0	0.0	0	0	.
9	1	0.8	4	0.6	12	3.5	-3	11	91.2%
10	1	0.8	4	0.6	7	2.6	-1	9	69.6%
11	0	0.0	0	0.0	0	0.0	0	0	.
12	0	0.0	0	0.0	.	.	.	.	.
Total	127	100.0	678	100.0	6,922	83.2	512	844	12.3%

Table 7c. Released catches of large salmon estimated by DFO catch statistics and creel survey methods at Big Falls, Humber River, 1995.

	Large salmon (released)								
	DFO		Creel						
Week	Estimate	% of Total	Estimate	% of Total	Variance	Std.Dev.	Lower C.I.	Upper C.I.	Coef. Var.
.	1	2.1							
1	10	21.3	19	18.6	49	7.0	5	33	36.3%
2	19	40.4	73	70.4	1077	32.8	7	139	44.9%
3	9	19.1	4	3.7	7	2.6	-1	9	69.6%
4	2	4.3	0	0.0	0	0.0	0	0	.
5	2	4.3	8	7.4	18	4.2	-1	16	55.1%
6	2	4.3	0	0.0	0	0.0	0	0	.
7	1	2.1	0	0.0	0	0.0	0	0	.
8	1	2.1	0	0.0	0	0.0	0	0	.
9	0	0.0	0	0.0	0	0.0	0	0	.
10	0	0.0	0	0.0	0	0.0	0	0	.
11	0	0.0	0	0.0	0	0.0	0	0	.
12	0	0.0	.	0.0	.	.	.	.	.
Total	47	100.0	104	100.0	1151	33.9	36	172	32.7%

Table 7d. Effort estimated by DFO catch statistics (rod days) and creel survey (hours) methods at Big Falls, Humber River, 1995.

	Effort								
	DFO (rod days)		Creel (hours)						
Week	Estimate	% of Total	Estimate	% of Total	Variance	Std.Dev.	Lower C.I.	Upper C.I.	Coef. Var.
.	2	0.1		0.0					
1	123	6.0	1,087	4.8	27,879	167.0	753	1,421	15.4%
2	369	18.1	4,311	19.0	360,910	600.8	3,110	5,513	13.9%
3	436	21.4	5,476	24.2	174,025	417.2	4,642	6,311	7.6%
4	324	15.9	3,430	15.1	55,952	236.5	2,957	3,903	6.9%
5	225	11.0	2,342	10.3	32,204	179.5	1,983	2,701	7.7%
6	218	10.7	1,937	8.6	77,577	278.5	1,380	2,494	14.4%
7	135	6.6	1,868	8.2	75,741	275.2	1,317	2,418	14.7%
8	69	3.4	818	3.6	45,849	214.1	390	1,246	26.2%
9	39	1.9	430	1.9	11,997	109.5	211	649	25.5%
10	55	2.7	279	1.2	11,325	106.4	66	491	38.2%
11	45	2.2	668	2.9	64,058	253.1	162	1,174	37.9%
12	0	0.0	.	0.0	.	.	.	.	.
Total	2,040	100.0	22,646	100.0	937,517	968.3	20,709	24,582	4.3%

Table 8. Catches of bright Atlantic salmon in Humber River tagging traps, 1990-1995.

	Large Salmon (>=63 cm)			Small Salmon (< 63 cm)			Ratio
Year	Lower Trap	Upper Trap	Total	Lower Trap	Upper Trap	Total	Large: Small
1990	18		18	242		242	0.0744
1991	3		3	94		94	0.0319
1992	30		30	179		179	0.1676
1993	22	10	32	668	242	910	0.0352
1994*	78	3	81	440	189	629	0.1288
1995	106	39	145	845	1115	1960	0.0740
Mean (92-94)	43		48	429		573	0.1105
N	3		3	3		3	3

* Estuary and Boom Siding tagging traps combined.

Table 9. Recaptures by anglers of small Atlantic salmon tagged at two trap locations on the Humber River, 1995.

Release Location	Tagging Week	Number Small Tagged	Recapture Week													Total Tags Returned
			Unk.	25	26	27	28	29	30	31	32	33	34	35	36	
Lower Trap	22	0														0
	23	0														0
	24	75		8	5	2		1								16
	25	257	5		14	12	5	1	4	1			2	1		45
	26	223	4		2	10	4	3		1	1		1	2		28
	27	153	6			2	7	3	1		1		1			21
	28	46						1		2	1					4
	29	43							1	2		1				4
	30	17								1	1			1		3
	31	3														0
	32	1														0
	33	3														0
	34	0														0
	35	0														0
	36	0														0
	Sub-Total	821	15	8	21	26	16	9	6	7	4	1	4	4	0	121
Upper Trap	22	0														0
	23	1														0
	24	4														0
	25	157		2	4	5	4	2			1	1	1	1	1	22
	26	308	7		2	8	5	3		1	1		1			28
	27	387	11			1	6	4	2	4	1	4	4	4		41
	28	197					1	3	4	4	2	3	1	1		19
	29	24									1					1
	30	13								1	1	1	1			4
	31	0														0
	32	0														0
	33	0														0
	34	0														0
	35	0														0
	36	0														0
	Sub-Total	1091	18	2	6	14	16	12	6	10	7	9	8	6	1	115
	Total	1912	33	10	27	40	32	21	12	17	11	10	12	10	1	236

Table 10. Recaptures by anglers of large Atlantic salmon tagged at two trapnet locations on the Humber River, 1995.

Release Location	Rel. Week	Large Tagged Rel.	Recapture Week							Total Tags Returned
			Unk.	28	29	30	31	32	33	
Lower	23	3								0
Trap	24	48		1		1				2
	25	27	1							1
	26	5					1			1
	27	7								0
	28	4		1						1
	29	2								0
	30	1								0
	31	2								0
	32	0								0
	33	0								0
	Sub-Total	99	1	2	0	1	1	0	0	5
Upper	22	0								0
Trap	23	2								0
	24	2								0
	25	6								0
	26	9								0
	27	5							1	1
	28	9								0
	29	2								0
	30	2								0
	31	0								0
	32	0								0
	33	0								0
	Sub-Total	37	0	0	0	0	0	0	1	1
	TOTAL	136	1	2	0	1	1	0	1	6

Table 11. Mean surface water temperatures recorded during tagging in 1995.

Lower Trap

Surface Temperature (C	Mean	No. Small Tagged	No. Recaptured	Proportion Recaptured
0.0-4.9	0	0	0	0
5.0-9.9	7.97	257	39	0.15
10.0-14.9	12.38	510	76	0.15
15.0-19.9	16.03	57	6	0.11
20 & up				
		824	121	0.15

Upper Trap

Surface Temperature (C	Mean	No. Small Tagged	No. Recaptured	Proportion Recaptured
0.0-4.9		0	0	0
5.0-9.9	7.4	227	26	0.11
10.0-14.9	12.5	839	83	0.10
15.0-19.9	16.3	27	6	0.22
20 & up				
		1093	115	0.11

Table 12. Recapture locations in angling of small Atlantic salmon tagged on the Humber River, 1995.

Release Location	Tagging Week	Number Small Tagged	Recapture Location Unk.	Lower Hum.	Deer Lake	Harri.	Little Falls	Big Falls	Adies Stream	Adies Lake	Taylors	Total Tags Returned
Lower Trap	23	0										0
	24	75	1			4	3	8				16
	25	257	2			12	4	24		1	2	45
	26	223				5	8	15				28
	27	153		2		8	2	8			1	21
	28	46						4				4
	29	43			2		1	1				4
	30	17		1				1			1	3
	31	3										0
	32	1										0
	33	3										0
	34	0										0
	Total	821	3	3	2	29	18	61	0	1	4	121
Upper Trap	23	1										0
	24	4										0
	25	157				5	2	14	1			22
	26	308	4			10	4	7			3	28
	27	387	3	3	2	8	6	14		2	3	41
	28	197		3	1	2	4	8			1	19
	29	24		1								1
	30	13	1	2		1						4
	31	0										0
	32	0										0
	33	0										0
	34	0										0
	Total	1091	8	9	3	26	16	43	1	2	7	115
	TOTAL	1912	11	12	5	55	34	104	1	3	11	236

Table 13. Recapture location in angling of large Atlantic salmon tagged on the Humber River, 1995.

Release Location	Tagging Week	Number Large Tagged	Recapture Location			Total Tags Returned
			Unk.	Big Falls	Taylors	
Lower Trap	23	3				
	24	48			2	2
	25	27	1			1
	26	5		1		1
	27	7		1		1
	28	4				
	29	2				
	30	1				
	31	2				
	32	0				
	33	0				
	Total	99	1	2	2	5
Upper Trap	23	2				
	24	2				
	25	6				
	26	9				
	27	5		1		1
	28	9				
	29	2				
	30	2				
	31	0				
	32	0				
	Total	37		1	0	1
	TOTAL	136	1	3	2	6

Table 14. Estimation by two week period of angling exploitation rate based on tags available from the two estuarial tagging traps in 1995. Adjustments are made for tag loss and reporting rate.

Release Period	No. Small Tagged* (X1)	Median Days to Recapture (X2)	Proportion of Tags Retained (X3=1-(X2*0.009))	Adjusted Tags Available (X4=X1*X3)	Tags Returned (Ret) (X5)	Reporting Rate (X6)	Adjusted Tags Recaptured (X7=X5/X6)	Adjusted Angling ER (X8=X7/X4)
22-23	1	.	1	1	0	0.6087	0	.
24-25	493	12	0.892	440	68	0.6087	112	0.254
26-27	1071	13	0.883	946	93	0.6087	153	0.1616
28-29	310	19	0.834	258	24	0.6087	39	0.1526
30-31	33	15	0.870	29	4	0.6087	7	0.2290
32-35	4	.	1.000	4	0	0.6087	0	.
	1912	13.4	0.880	1682	189	0.6087	310	0.1846

* No adjustment is made for tagged salmon not destined for the Humber River.

Table 15. Sea-age distribution of small and large Atlantic salmon of the Humber River, 1988-1995.

a. Angling

		SEA-AGE					
		1SW		1SW RS		Total	
		N	%	N	%	N	%
SIZE:	YY						
Large	88	1	100.0	.	.	1	100.0
	90	1	100.0	.	.	1	100.0
	92	3	100.0	.	.	3	100.0
	93	.	.	1	100.0	1	100.0
	94	3	100.0	.	.	3	100.0
	Total	8	88.9	1	11.1	9	100.0
Small	YY						
	88	77	100.0	.	.	77	100.0
	89	126	100.0	.	.	126	100.0
	90	55	98.2	1	1.8	56	100.0
	91	170	98.8	2	1.2	172	100.0
	92	342	99.7	1	0.3	343	100.0
	93	130	98.5	2	1.5	132	100.0
	94	331	99.1	3	0.9	334	100.0
	95	109	99.1	1	0.9	110	100.0
	Total	1340	99.3	10	0.7	1350	100.0

b. Tagging Traps

		SEA-AGE									
		1SW		2SW		1SW RS		2SW RS		Total	
		N	%	N	%	N	%	N	%	N	%
SIZE:	YY										
Large	89	.	.	2	40.0	3	60.0	.	.	5	100.0
	90	6	28.6	7	33.3	7	33.3	1	4.8	21	100.0
	91	.	.	.	.	4	100.0	.	.	4	100.0
	92	1	3.6	21	75.0	6	21.4	.	.	28	100.0
	93	1	1.8	28	50.0	10	17.9	17	30.4	56	100.0
	94	7	8.6	23	28.4	50	61.7	1	1.2	81	100.0
	95	.	.	61	43.6	77	55.0	2	1.4	140	100.0
	Total	15	4.5	142	42.4	157	46.9	21	6.3	335	100.0
Small	YY										
	90	243	95.3	.	.	12	4.7	.	.	255	100.0
	91	95	92.2	.	.	8	7.8	.	.	103	100.0
	92	175	96.7	.	.	6	3.3	.	.	181	100.0
	93	904	96.4	1	0.1	33	3.5	.	.	938	100.0
	94	608	97.9	.	.	13	2.1	.	.	621	100.0
	95	405	99.0	.	.	4	1.0	.	.	409	100.0
	Total	2430	96.9	1	0.0	76	3.0	.	.	2507	100.0

Table 16. Mean fork length, weight of females and sex composition of small and large Atlantic salmon of the Humber River, 1988-1995.

a. Angling

		FORK LENGTH (cm)					WHOLE WEIGHT FEMALES (kg)					NO.	PERCENT FEMALE	
		N	MEAN	MIN	MAX	STD	N	MEAN	MIN	MAX	STD	SEXED	N	%
Large	YY													
	88	1	63.2	63.2	63.2	.	0	.	.	.	.	0	0	.
	90	1	63.5	63.5	63.5	.	0	.	.	.	.	1	1	100.0
	92	3	63.0	63.0	63.0	0.0	1	2.7	2.7	2.7	.	2	1	50.0
	93	1	63.0	63.0	63.0	.	1	2.4	2.4	2.4	.	1	1	100.0
	94	3	63.0	63.0	63.0	0.0	0	.	.	.	.	0	0	.
	Total	9	63.1	63.0	63.5	0.2	2	2.6	2.4	2.7	0.2	4	3	75.0
Small	YY													
	88	72	55.7	48.0	62.0	3.0	0	.	.	.	.	0	0	.
	89	149	54.3	43.3	62.0	3.0	9	1.4	1.0	1.8	0.3	86	37	43.0
	90	54	56.4	49.0	62.5	3.3	0	.	.	.	.	27	19	70.4
	91	164	54.3	45.7	62.0	2.7	65	1.6	1.2	2.5	0.2	130	66	50.8
	92	357	56.1	48.5	62.5	2.6	57	2.0	1.5	2.5	0.3	254	138	54.3
	93	127	55.6	48.0	62.5	2.9	49	1.7	1.0	2.4	0.3	83	56	67.5
	94	372	55.6	48.0	62.8	2.9	21	1.7	1.3	2.4	0.3	112	57	50.9
	95	118	55.5	48.0	62.0	2.7	18	1.6	1.2	1.9	0.2	72	37	51.4
	Total	1E3	55.5	43.3	62.8	2.9	219	1.7	1.0	2.5	0.3	764	410	53.7

b. Tagging Traps

		FORK LENGTH (cm)					WHOLE WEIGHT FEMALES (kg)					NO.	PERCENT FEMALE	
		N	MEAN	MIN	MAX	STD	N	MEAN	MIN	MAX	STD	SEXED	N	%
Large	YY													
	89	5	75.6	71.5	77.5	2.4	0	.	.	.	.	5	5	100.0
	90	22	72.6	63.0	92.0	8.3	0	.	.	.	.	0	0	.
	91	4	77.5	75.5	80.0	2.1	0	.	.	.	.	0	0	.
	92	29	75.2	63.6	91.0	5.2	0	.	.	.	.	0	0	.
	93	56	72.6	63.2	90.6	6.0	1	5.0	5.0	5.0	.	1	1	100.0
	94	82	74.1	63.0	88.5	5.8	0	.	.	.	.	0	0	.
	95	143	75.8	63.1	115.0	5.9	0	.	.	.	.	0	0	.
	Total	341	74.6	63.0	115.0	6.0	1	5.0	5.0	5.0	.	6	6	100.0
Small	YY													
	89	2	52.5	51.4	53.5	1.5	0	.	.	.	.	0	0	.
	90	255	54.7	43.9	62.8	3.7	0	.	.	.	.	29	21	72.4
	91	102	52.3	37.3	61.3	3.5	24	1.3	0.9	1.9	0.2	39	27	69.2
	92	181	53.7	34.7	62.0	3.3	14	1.8	1.0	2.8	0.5	22	17	77.3
	93	937	53.4	38.3	62.6	2.9	37	1.4	1.0	2.6	0.3	59	40	67.8
	94	624	53.2	44.0	62.8	2.8	4	2.0	1.5	2.3	0.4	9	4	44.4
	95	2E3	52.9	39.4	62.9	2.6	0	.	.	.	.	5	3	60.0
	Total	4E3	53.2	34.7	62.9	2.9	79	1.5	0.9	2.8	0.4	163	112	68.7

Table 17. Smolt-age distribution of small and large Atlantic salmon of the Humber River, 1988-1995. Virgin spawners only.

a. Angling

		SMOLT-AGE												Total		
		2			3			4			5					
		N	%	MEAN	N	%	MEAN	N	%	MEAN	N	%	MEAN	N	%	MEAN
Large	YY															
	88	.	.	.	1	100.0	3.0	.	.	.	.	.	.	1	100.0	3.0
	90	.	.	.	1	100.0	3.0	.	.	.	.	.	.	1	100.0	3.0
	92	.	.	.	2	66.7	3.0	1	33.3	4.0	.	.	.	3	100.0	3.3
	94	.	.	.	2	66.7	3.0	1	33.3	4.0	.	.	.	3	100.0	3.3
	Total	.	.	.	6	75.0	3.0	2	25.0	4.0	.	.	.	8	100.0	3.3
Small	YY															
	88	2	2.6	2.0	48	62.3	3.0	27	35.1	4.0	.	.	.	77	100.0	3.3
	89	7	5.6	2.0	95	75.4	3.0	23	18.3	4.0	1	0.8	5.0	126	100.0	3.1
	90	2	3.6	2.0	32	58.2	3.0	21	38.2	4.0	.	.	.	55	100.0	3.3
	91	10	6.0	2.0	132	78.6	3.0	26	15.5	4.0	.	.	.	168	100.0	3.1
	92	9	2.6	2.0	282	82.7	3.0	50	14.7	4.0	.	.	.	341	100.0	3.1
	93	2	1.6	2.0	97	75.2	3.0	30	23.3	4.0	.	.	.	129	100.0	3.2
	94	4	1.2	2.0	183	55.6	3.0	141	42.9	4.0	1	0.3	5.0	329	100.0	3.4
	95	.	.	.	59	54.1	3.0	50	45.9	4.0	.	.	.	109	100.0	3.5
	Total	36	2.7	2.0	928	69.6	3.0	368	27.6	4.0	2	0.1	5.0	1E3	100.0	3.3

b. Tagging Traps

		SMOLT-AGE												Total		
		2			3			4			5					
		N	%	MEAN	N	%	MEAN	N	%	MEAN	N	%	MEAN	N	%	MEAN
Large	YY															
	89	.	.	.	2	100.0	3.0	.	.	.	.	.	.	2	100.0	3.0
	90	1	7.7	2.0	9	69.2	3.0	3	23.1	4.0	.	.	.	13	100.0	3.2
	92	2	9.1	2.0	19	86.4	3.0	1	4.5	4.0	.	.	.	22	100.0	3.0
	93	4	13.8	2.0	22	75.9	3.0	3	10.3	4.0	.	.	.	29	100.0	3.0
	94	.	.	.	16	55.2	3.0	13	44.8	4.0	.	.	.	29	100.0	3.4
	95	.	.	.	29	47.5	3.0	32	52.5	4.0	.	.	.	61	100.0	3.5
	Total	7	4.5	2.0	97	62.2	3.0	52	33.3	4.0	.	.	.	156	100.0	3.3
Small	YY															
	90	8	3.3	2.0	210	86.8	3.0	24	9.9	4.0	.	.	.	242	100.0	3.1
	91	2	2.1	2.0	89	93.7	3.0	4	4.2	4.0	.	.	.	95	100.0	3.0
	92	6	3.4	2.0	130	74.7	3.0	38	21.8	4.0	.	.	.	174	100.0	3.2
	93	28	3.1	2.0	752	84.3	3.0	112	12.6	4.0	.	.	.	892	100.0	3.1
	94	5	0.8	2.0	341	56.4	3.0	257	42.5	4.0	2	0.3	5.0	605	100.0	3.4
	95	.	.	.	182	44.9	3.0	220	54.3	4.0	3	0.7	5.0	405	100.0	3.6
	Total	49	2.0	2.0	2E3	70.6	3.0	655	27.1	4.0	5	0.2	5.0	2E3	100.0	3.3

Table 18. Estimation of total catch of retained small Atlantic salmon on the Humber River, 1995.

SMALL CATCH (Ret. = **a) Adjusted Catch at Big Falls** / **b) Proportion Humber Catch from Big Falls**

= **2534** / **0.4921**

= 5,150 (4,799 - 5,557)

Where:

a) Adjusted Catch at Big Falls = Creel Survey catch (Ret) from Falls Area / Prop. Catch (Ret) from Falls Area

Area	Ret. Prop. Tags	Tags/Catch
Mistaken Point	23	0.2473
Falls	68	0.7312
Smooth Rapids	2	0.0215
Total	93	1.0000

= 1853 / 0.7312 (0.699 - 0.763)

= **2,534** (2,386 - 2,669)

b) Prop. Humber Catch from Big Falls = Tag Returns (Ret) from Big Falls / Total Tag Returns (Ret) on Humber = 93 / 189 = **0.4921**

Table 19. Estimated returns and spawning escapement of Atlantic salmon on the Humber River, 1995.

		Parameter Value	95% C.I. Lower	Upper
ESTIMATED PARAMETERS:				
Tags Recaptured*		310	272	335
Tags Available**		1,682	1,645	1,713
Exploitation Rate		0.1846	0.1653	0.1956
Ratio Large:Small		0.0740	0.070	0.078
Total Catch Small (Retained)		5,150	4,799	5,557
ESTIMATED RETURNS AND SPAWNING ESCAPEMENT:				
1. Petersen - single census estimate (95% CI from Ricker (1975))				
Returns:				
	SMALL	27,898	25,001	31,232
	LARGE	2,064	1,953	2,176
	TOTAL	29,963	26,953	33,408
Potential Spawning Escapement:				
	SMALL	22,748	20,202	25,675
	LARGE	2,064	2,176	2,176
	TOTAL	24,813	22,378	27,851
2. Darroch - stratified estimate (95% CI based on S.E.=1441.85)				
Returns:				
	SMALL	27,254	24,428	30,080
	LARGE	2,017	1,908	2,126
	TOTAL	29,271	26,336	32,206
Potential Spawning Escapement:				
	SMALL	22,104	19,629	24,523
	LARGE	2,017	1,908	2,126
	TOTAL	24,121	21,537	26,649

* Adjusted for mean reporting rate of 0.6087

** Adjusted for tag loss based on 0.009 tags/day.

Table 20. Estimation of Atlantic salmon egg deposition and percentage conservation requirement achieved in the Humber River, 1995. All parameter values are from Porter and Chadwick (1983) except where noted.

HUMBER RIVER

Rearing Units - (100 sq. m)		115,307	
Lacustrine Area (ha)		1,751 (Mullins and Chaput, MS 1994)	
Optimum Egg Deposition		240 eggs per Rearing Unit 368 eggs per hectare of Lacustrine Area	
Biological Characteristics, 1995:			
Fecundity		1,540 eggs / kg	
Small - (<63 cm)	% overall	93.1	(trapnet, 1995)
	% female	51.39 (n=72)	(recreational, 1995)
	mean wt females	1.58 kg (n=18)	(recreational, 1995)
Large - (>=63 cm)	% overall	6.9	(trapnet, 1995)
	% female	68.6	(commercial, 1991)
	mean wt females	3.7 + kg	

Percent Target Eggs Achieved, 1995:

= potential egg depositions / minimum conservation requirement X 100

$$= \frac{\text{small spawners x (eggs per small spawner) + large spawners x (eggs per large spawner)}}{\text{(Rearing Units x 240 eggs / unit) + (Lacustrine Area x 368 eggs / ha)}} \times 100$$

Where:

Eggs per Small Spawner = (.5139 * 1.58 * 1,540)
= 1,250

Eggs per Large Spawner = (.686 * 3.7 * 1,540)
= 3,909

$$= \frac{\text{(small spawners x eggs per spawner) + (large spawners x eggs per spawner)}}{28{,}318{,}048} \times 100$$

Where:		Petersen (single census)
Small Spawners	=	22,748
Large Spawners	=	2,064
Total	=	24,812

= 129%

Table 21. Summary of Atlantic salmon spawning escapement and percent of target requirements achieved on the Humber River, 1974-1995.

Target Spawning Requirement: 28.3 million eggs (13,651 Small and 1,326 Large salmon)

	Estimated Returns			Angling Catch		Spawning Escapement			% Target
Year	Small	Large	Total	Small	Large	Small	Large	Total	Achieved
1974	10,968	768	11,736	2,742	107	8,226	661	8,887	52
1975	24,588	1,721	26,309	6,147	114	18,441	1,607	20,048	119
1976	20,408	1,429	21,837	5,102	61	15,306	1,368	16,674	100
1977	8,632	604	9,236	2,158	45	6,474	559	7,033	42
1978	10,888	762	11,650	2,722	187	8,166	575	8,741	50
1979	13,372	936	14,308	3,343	27	10,029	909	10,938	66
1980	14,048	983	15,031	3,512	303	10,536	680	11,216	64
1981	16,528	1,157	17,685	4,132	153	12,396	1,004	13,400	79
1982	17,148	1,200	18,348	4,287	95	12,861	1,105	13,966	83
1983	12,440	871	13,311	3,110	47	9,330	824	10,154	61
1984	11,488	804	12,292	2,872	40	8,616	764	9,380	56
1985	9,720	680	10,400	2,430	11	7,290	680	7,970	48
1986	13,824	968	14,792	3,456	261	10,368	968	11,336	68
1987	12,296	861	13,157	3,074	113	9,222	861	10,083	61
1988	16,168	1,132	17,300	4,042	144	12,126	1,132	13,258	80
1989	4,868	341	5,209	1,217	10	3,651	341	3,992	24
1990	12,216	855	13,071	3,054	75	9,162	855	10,017	60
1991	5,724	401	6,125	1,431	11	4,293	401	4,694	27
1992	17,571	2,945	20,516	4,349	177	13,222	2,945	16,167	117
1993	18,477	636	19,113	4,161	125	14,316	636	14,952	96
1994	7,995	1,030	9,025	2,523	166	5,472	1,030	6,502	40
1995	27,898	2,064	29,963	5,150	233	22,748	2,064	24,812	129
Mean (92-94)	14681	1537	16218	3678	156	11003	1537	12540	84
Mean (90-94)	12397	1173	13570	3104	111	9293	1173	10466	68

Note1: Total returns for 1974-1991 estimated based on an angling exploitation rate of 25% adjusted for tag loss and reporting rate (Chaput and Mullins, 1990)

Note2: 1974-1990 is based on biological characteristics from Porter and Chadwick, 1983.

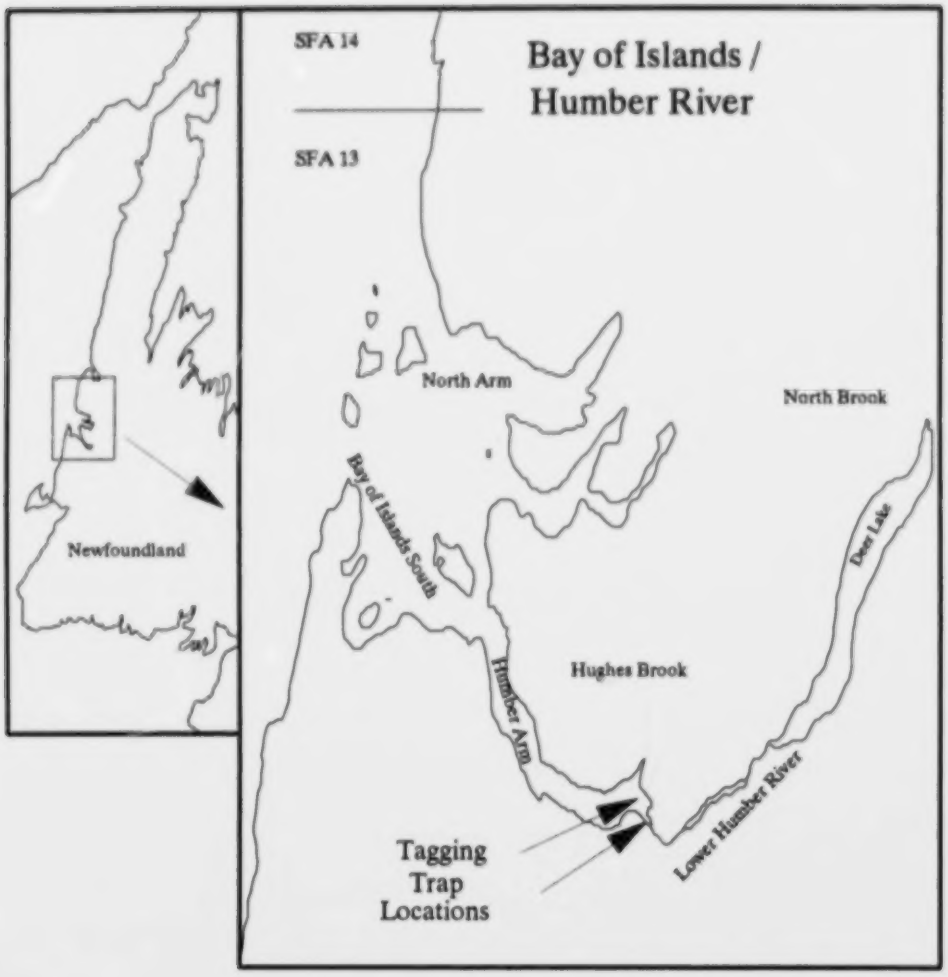


Figure 1. Location of two Atlantic salmon tagging traps operated on the Humber River in 1995.

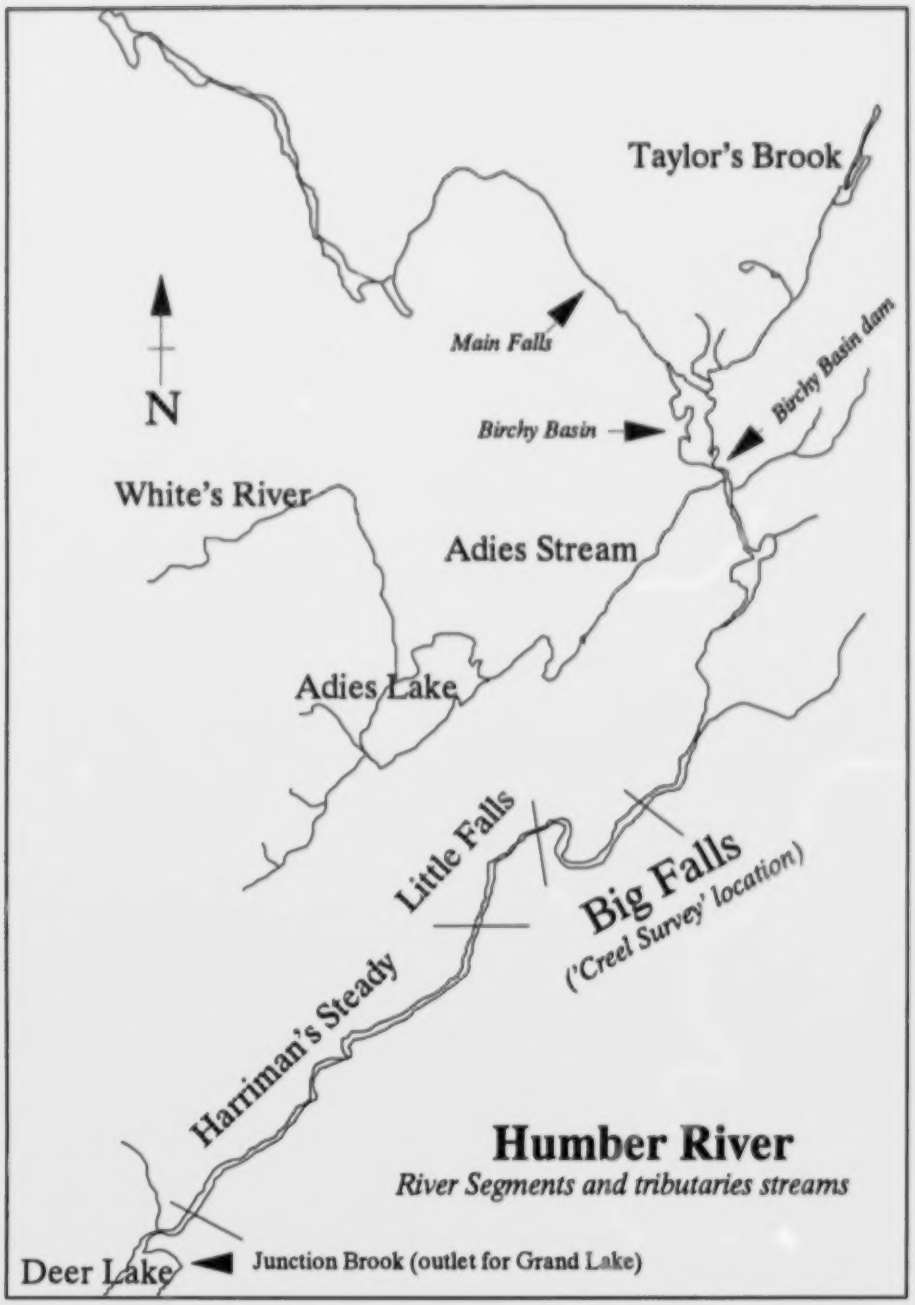


Figure 2. River segments of the Humber River, upstream of Deer Lake and showing the Big Falls Creel Survey location.

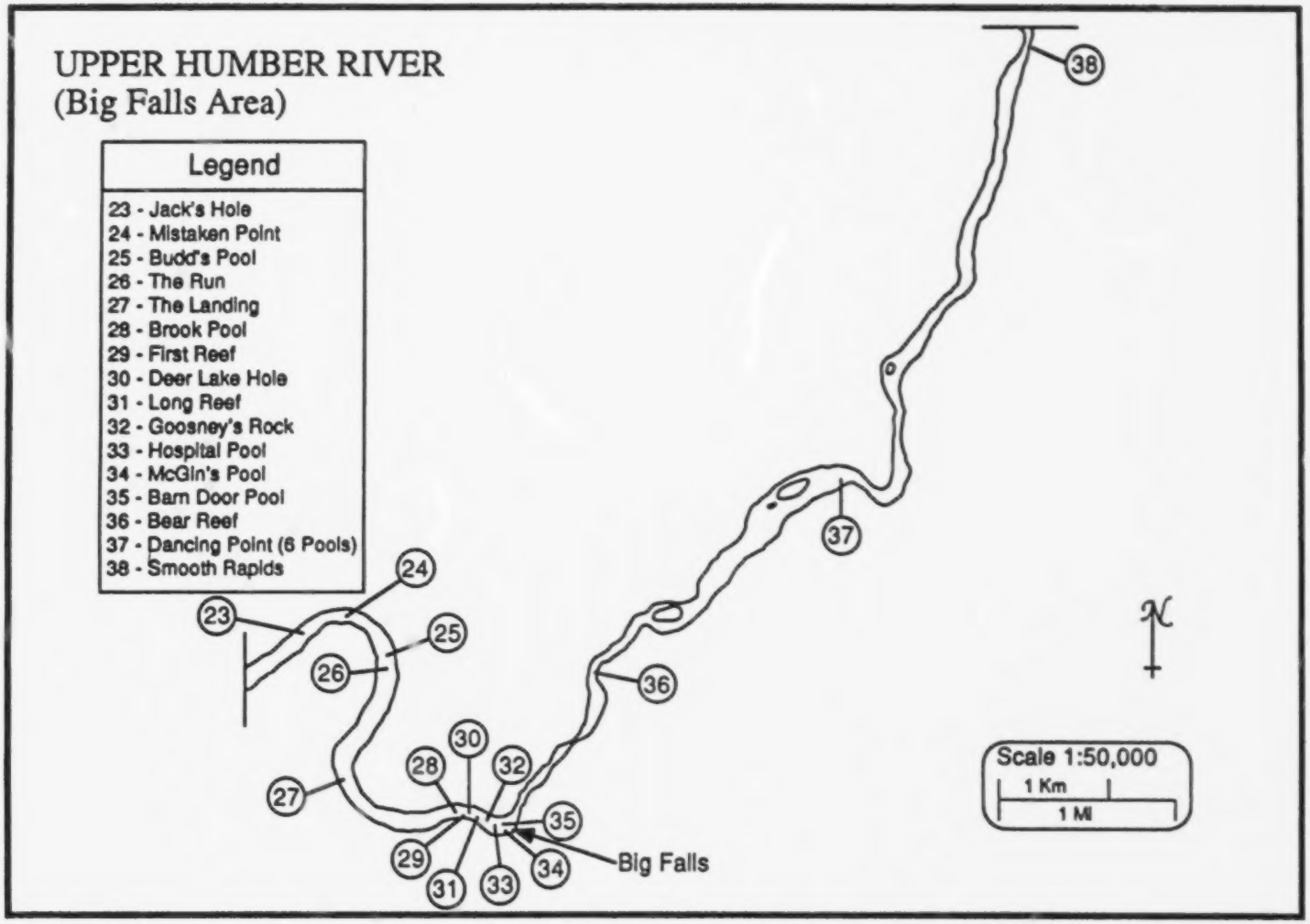


Figure 3. Location of major salmon angling pools in the Big Falls area of the Humber River. Pools 28-35 were included in the 1995 creel survey (from Hare, 1990).

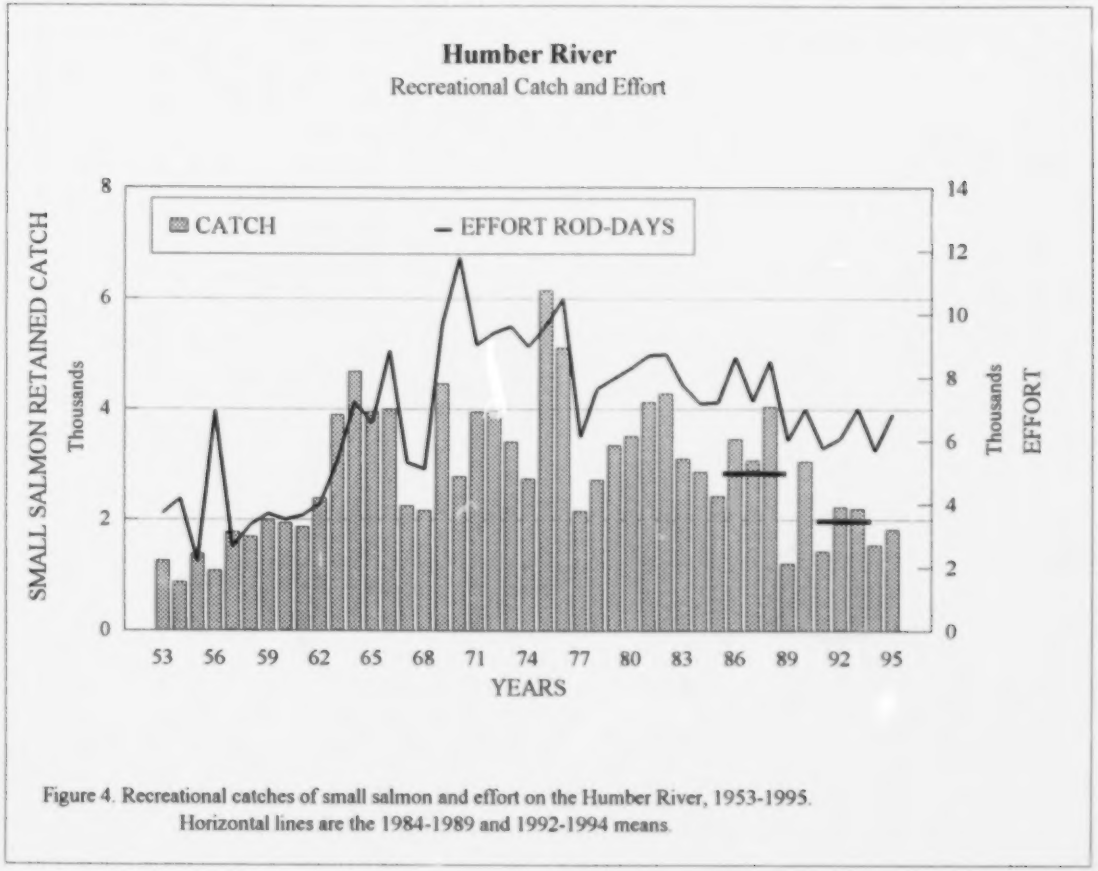


Figure 4. Recreational catches of small salmon and effort on the Humber River, 1953-1995. Horizontal lines are the 1984-1989 and 1992-1994 means.

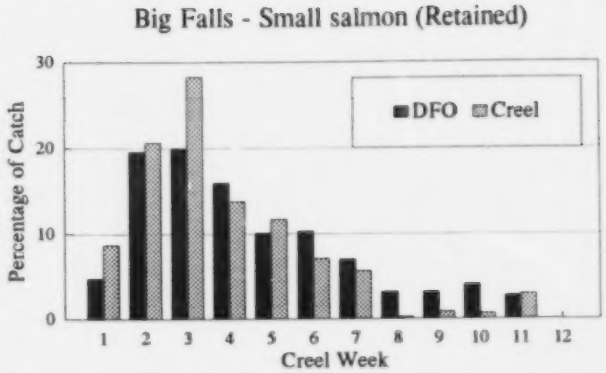


Figure 5. Distribution of small salmon retained catches from DFO and Creel survey estimates at Big Falls, 1995.

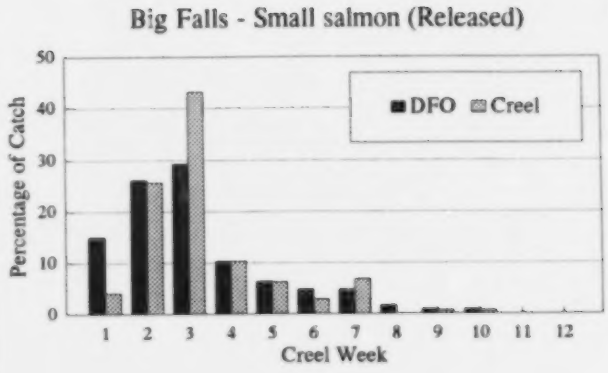


Figure 6. Distribution of small salmon released catches from DFO and Creel survey estimates at Big Falls, 1995.

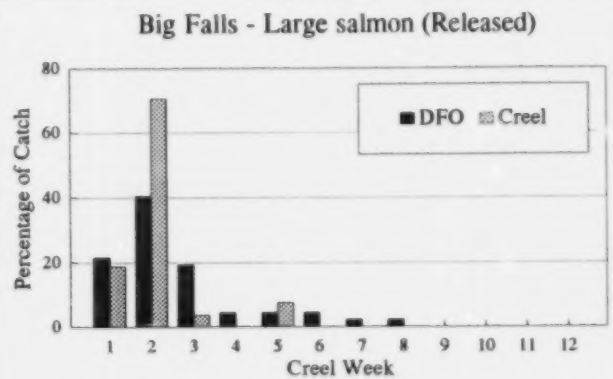


Figure 7. Distribution of large salmon released catches from DFO and Creel survey estimates at Big Falls, 1995.

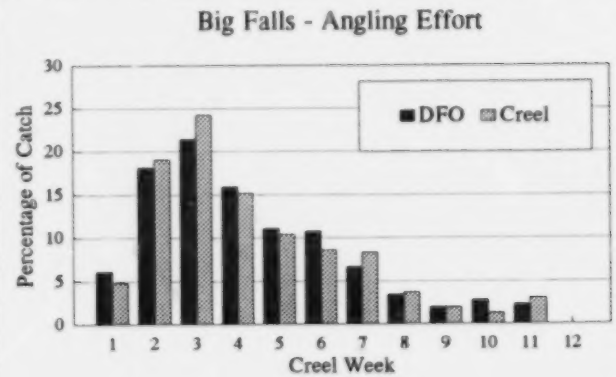


Figure 8. Distribution of angling effort from DFO (rod days) and Creel survey (hours) estimates at Big Falls, 1995.

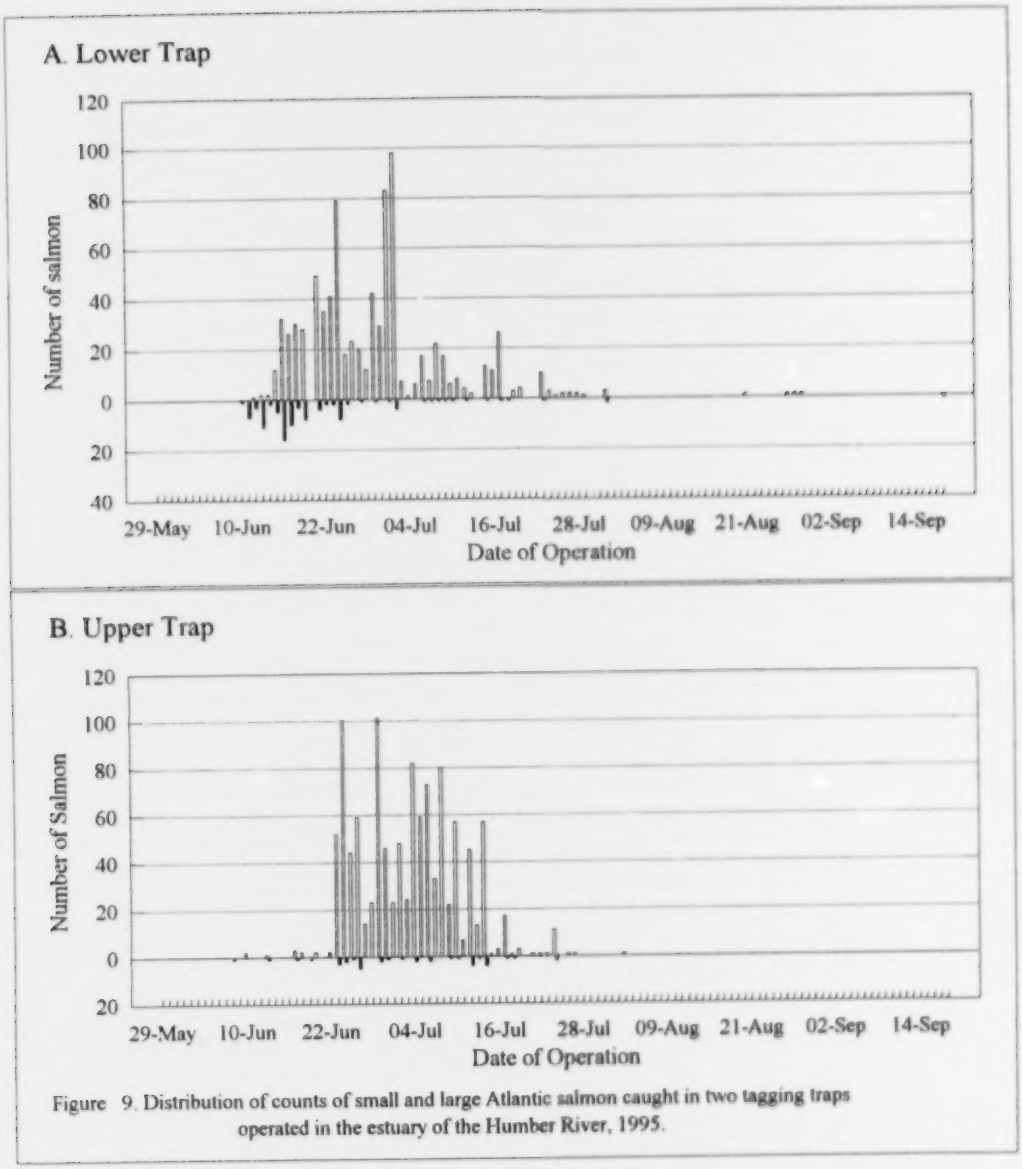
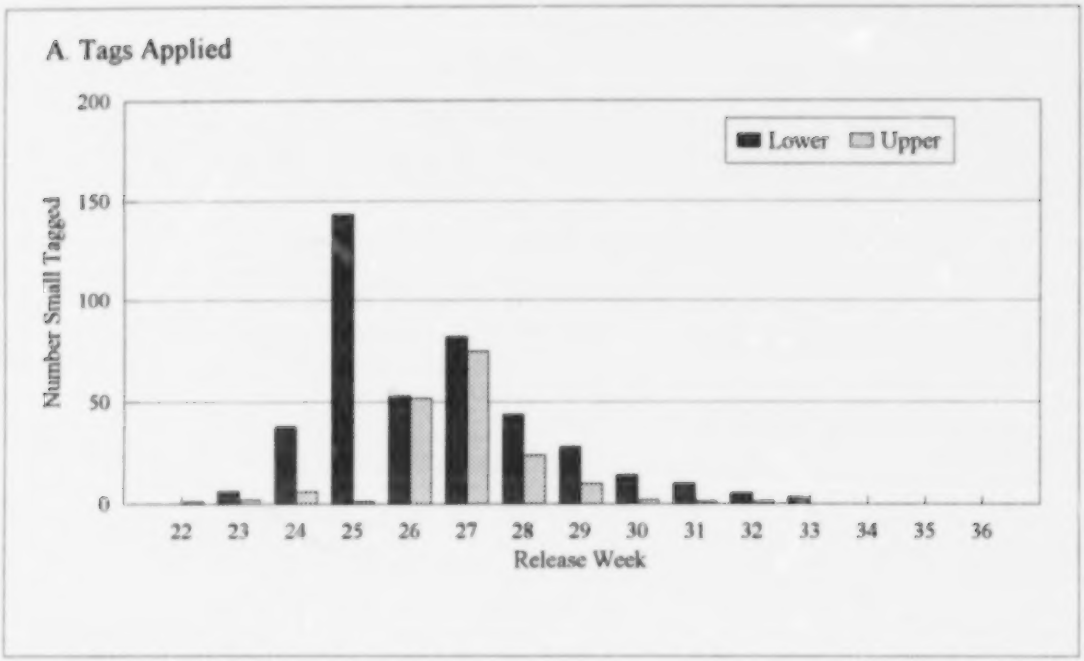


Figure 9. Distribution of counts of small and large Atlantic salmon caught in two tagging traps operated in the estuary of the Humber River, 1995.



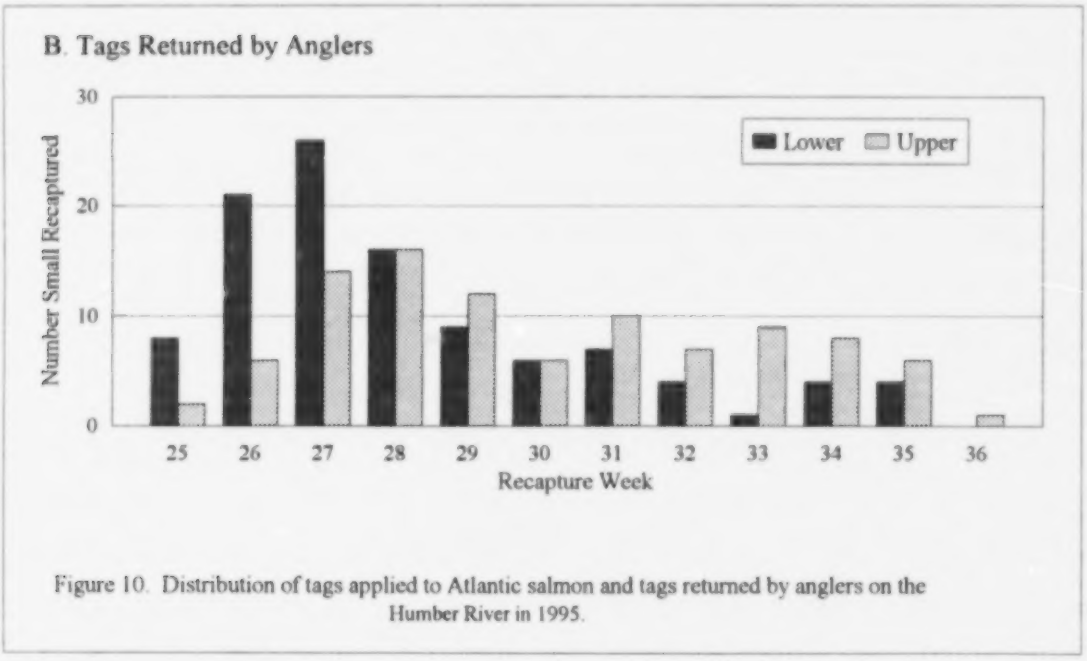


Figure 10. Distribution of tags applied to Atlantic salmon and tags returned by anglers on the Humber River in 1995.

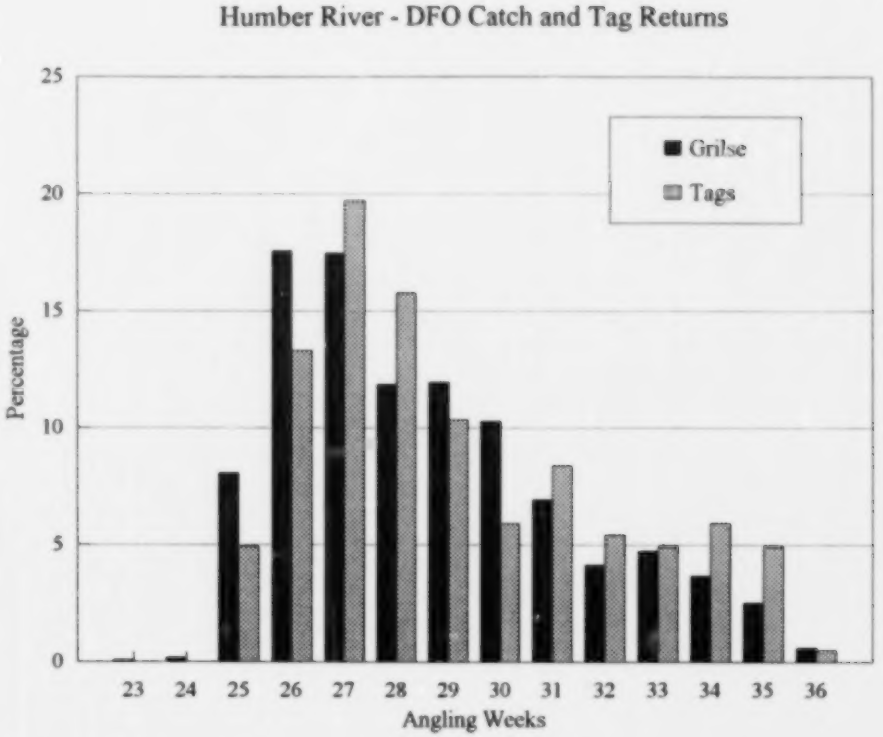


Figure 11. Distribution of recreational catches of small Atlantic salmon and tag recaptures on the Humber River, 1995.

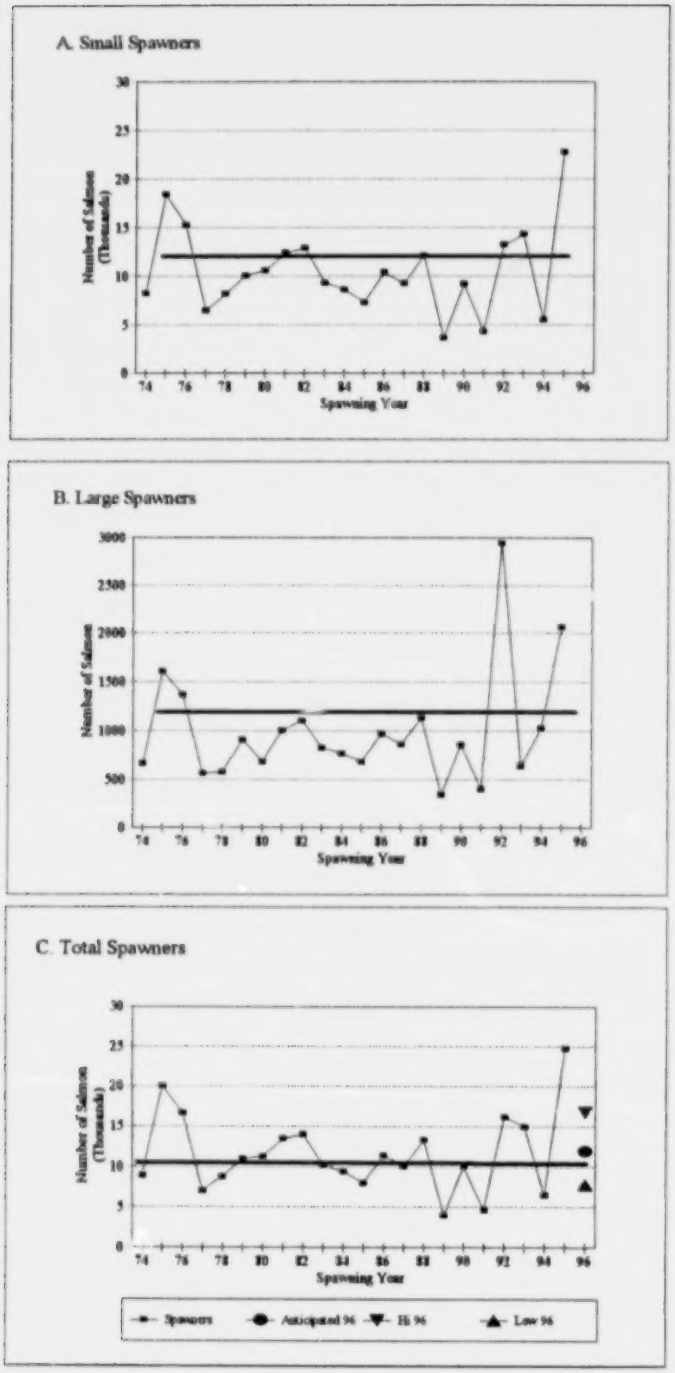


Figure 12. Small, large and total Atlantic salmon spawners on the Humber River in 1974-1995 and anticipated spawners in 1996.

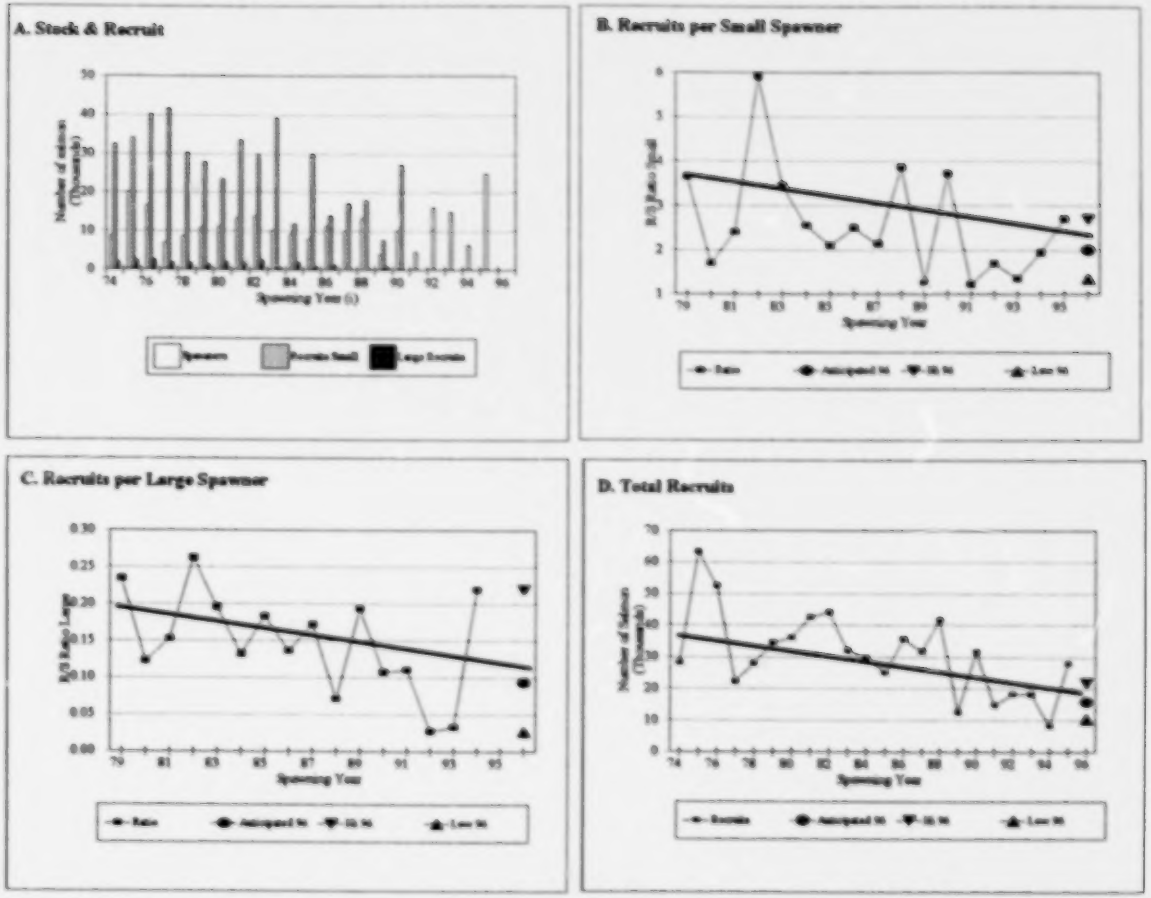


Figure 13. Stock and recruit relationship for Humber River Atlantic salmon 1974-1995 and anticipated values for 1996. Diagonal lines are trend lines.

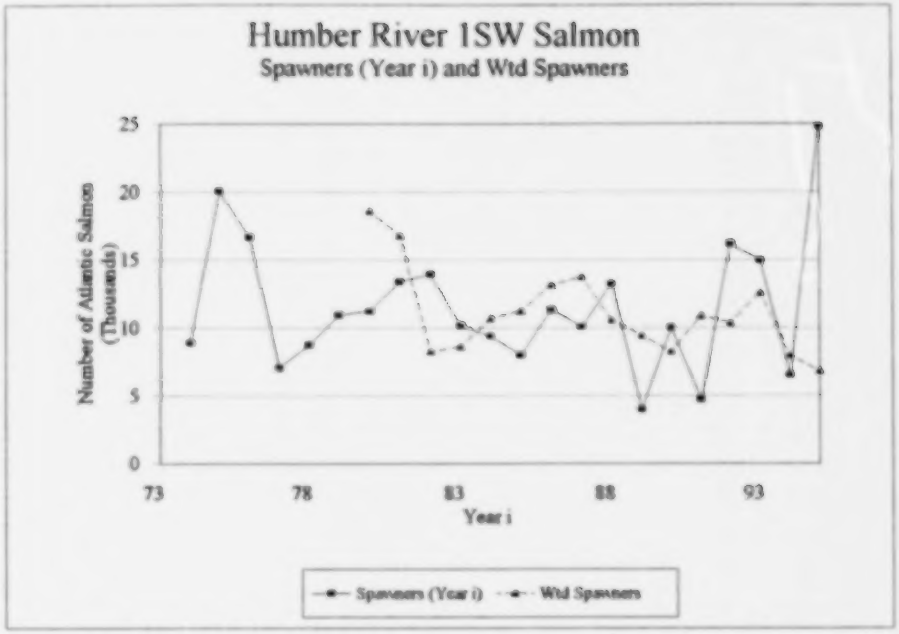


Figure 14. Relationship between total spawners in Year i and spawner recruits adjusted for yearclass (wtd spawners).

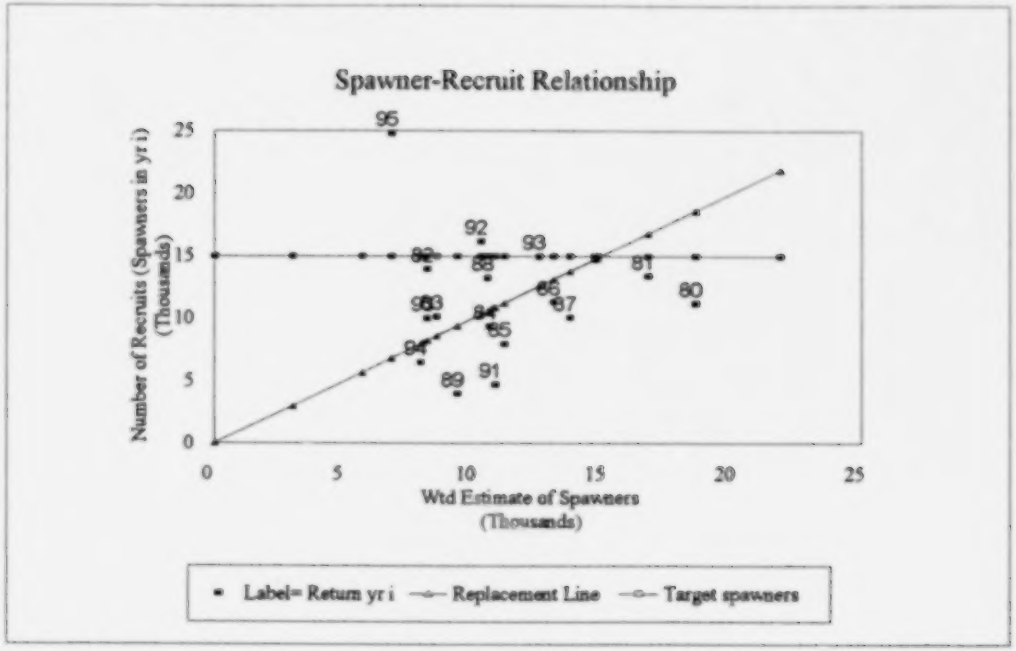


Figure 15. Relationship between 1SW salmon spawners and recruits on the Humber River, 1980-1995.

Appendix 1. Big Falls Creel survey instructions, 1995.

The creel survey at Big Falls is designed similar to a bus route. The clerk travels to one location, waits a fixed interval of time, then moves on to next site and waits required interval of time at second site, etc. For Big Falls, only two sites have been designated, therefore, the route is very simple.

The two designated stops on the survey route are near the boat landing spot (designated as "Boat") and at the stairs immediately upstream of the boat landing (designated as "Stair"). The standard waiting period at the "Boat" location is 4 hours (240 minutes) while the "Stair" stop period is 1 hour (60 minutes).

The day is divided into four time periods as follows:

A - 5:30 to 10:00 AM
B - 10:00 AM to 2:00 PM
C - 2:00 to 6:00 PM
D - 6:00 to 10:30 PM

At each stop the clerk will interview as many anglers departing as possible.

Critical data to be obtained and recorded by the survey clerk during interviews with anglers include:

1. number of hours fished (start time and end time),
2. number of grilse kept,
3. number of grilse released,
4. number of large salmon released.

Any grilse which are kept by the angler should be examined for the following critical features:

1. presence of external Carlin tag (green) - be sure to record number
2. if no tag is present on fish, examine for tagging scar, two holes immediately below the dorsal fin.
3. if time permits, collect fork length, whole weight, and scale sample (if present)

NOTE: It is most important to get accurate count of fish being caught, presence or absence of tags or tagging scars and hours fished. The collection of length, weight and scales is secondary.

The starting point of the survey and the time which the clerk spends at the very first stop may vary from day to day and period to period. The starting point and the duration of the initial stop are given on the schedule. The clerk is expected to work the duration of each time period and this may involve moving between the two interview locations several times.

For example, looking at the example schedule, we see that for June 13, 1991 a creel is to be conducted during the 10:00 to 2:00 PM period. Looking at the schedule, the starting point is location 'boat' at time 10:00. The clerk should be ready to start intercepting anglers at that time at the boat landing site. Note also that the clerk would spend 30 minutes there (from 10:00 to 10:30) at which time, the person would move to the other location, stair. The clerk will stay at stair for 1 hour (10:45 to 11:45 assuming that the travel time from the boat lan ng spot to the bottom of the stair is 15 minutes) and intercept departing anglers. At 11:45, the clerk leaves and moves to the boat landing again. Assuming that the walk takes 15 minutes, then the clerk would intercept anglers at the boat landing between 12:00 and 2:00 PM at which time the sampling for that time period is over.

Appendix 2. Tags available and tags returned from angling on the Humber River, 1995.

Tags available unadjusted for tag loss and tags returned unadjusted for reporting rate.

Release Period	Unadjuste Tags Available	Unadjusted Tags Recaptured	Recapture Period Unk Wk	24-25	26-27	28-29	30-31	32-33	34-35	36-37	TOTAL
RETAINED FISH											
22-23	1	0	0	0	0	0	0	0	0	0	0
24-25	493	68	2	7	28	7	4	2	5	1	56
26-27	1071	93	13	0	17	28	5	6	12	0	81
28-29	310	24	0	0	0	4	11	4	2	0	21
30-31	33	4	0	0	0	0	1	2	0	0	3
32-35	4	0	0	0	0	0	0	0	0	0	0
Total	1912	189	15	7	45	39	21	14	19	1	161
UNKNOWN RET. OR REL.											
22-23			0	0	0	0	0	0	0	0	0
24-25			2	2	7	3	1	0	0	0	15
26-27			8	0	1	3	2	0	1	0	15
28-29			0	0	0	0	1	2	0	0	3
30-31			0	0	0	0	0	1	1	0	2
32-35			0	0	0	0	0	0	0	0	0
Total	0	0	10	2	8	6	4	3	2	0	35

Tags available adjusted for tag loss and tags returned adjusted for reporting rate = 0.6087

Release Period	Adjusted Tags Available	Adjusted Tags Recaptured	Adjusted Tag Returns from Retained Small Salmon Recapture Period 24-25	26-27	28-29	30-31	32-33	34-35	36-37	TOTAL
22-23	1	0	0	0	0	0	0	0	0	0
24-25	440	112	15	59	17	8	3	8	2	112
26-27	946	153	0	35	63	16	11	26	0	152
28-29	258	39	0	0	6	19	10	3	0	38
30-31	29	7	0	0	0	2	5	2	0	8
32-35	4	0	0	0	0	0	0	0	0	0
Total	1678	310	15	94	86	45	29	39	2	310

Appendix 3. Collapsed data matrix and maximum-likelihood estimate of returns of small salmon to the Humber River, 1995.

Pooling in effect:
ROW 1 = (22-23,24-25)
ROW 2 = (26-27)
ROW 3 = (28-29,30-31,32-35)
COL 1 = (23-25,26-27,28-29)
COL 2 = (30-31,32-33,34-35,36-37)

Input Data

S = 3 , T = 2

The nc(i) vector is...

ROW 1	ROW 2	ROW 3
441.00	946.00	291.00

The nr(j) vector is...

COL 1	COL 2
3202.00	1957.00

The marks never seen again are...

ROW 1	ROW 2	ROW 3
329.00	795.00	244.00

The u(j) vector is...

COL 1	COL 2
3007.00	1842.00

The m(i,j) matrix is...

	COL 1	COL 2
ROW 1	91.00	21.00
ROW 2	98.00	53.00
ROW 3	6.00	41.00

Output Data

The E[m(i,j)] matrix is...

	COL 1	COL 2
ROW 1	82.86	16.89
ROW 2	108.37	69.50
ROW 3	5.59	34.68

The estimated stratification at recapture time...

COL 1	COL 2
11959.26	15241.11

The probability of recapture estimates...

COL 1	COL 2
2677	1284

Log likelihood = 8171.84
Estimated population size (std. err.) = 27254.43 (1441.85)
G2 goodness of fit = 9.669519 X2 goodness of fit = 9.449512

---------- End of run ----------

Appendix 4. Total production from Humber River, Nfld salmon stocks.

Spawning Year (i)	Recruit Year (i+5)	Total river escapement		Adjusted river escapement		Total recruits (R/S 4)		(R/S 2)		Angling Removals			Spawning escapement			Spawning escapement adj. for Recruit year (i+5)			Total recruits adj. for year class			Recruits/spawners (R/S ratio)			% large salmon by smolt class	Multiplier for large salmon
		Small	Large	Small	Large	Small	Large	Total		Small	Large	Total	Small	Large	Total	Small	Large	Total	Small	Large	Total	Small	Large	Total		
74	79	10960	760	10636	326	26579	1628	28206		2742	[illegible]	2869	8226	661	8887					1628						
75	80	24389	1721	23833	730	59583	3648	63231		6147	134	6281	18441	1607	20048											
76	81	28400	1429	19701	695	49436	3029	52402		5102	63	5163	15306	1360	16674											
77	82	8632	604	8387	236	20917	1288	22193		2158	45	2203	6474	559	7033											
78	83	10880	762	10556	323	26384	1615	27999		2722	167	2909	8166	575	8741											
79	84	13572	936	12961	397	32404	1984	34388		3343	27	3370	10029	909	10939	8228	661	8887								
80	85	14040	923	13617	417	34042	2083	36125		3512	303	3815	10536	680	11216	18441	1607	20048								
81	86	16520	1157	14021	450	40051	2452	42504		4132	153	4285	12396	1004	13400	15306	1360	16674								
82	87	17340	1200	16422	509	41550	2543	44097		4287	95	4382	12881	1105	13966	6474	559	7033								
83	88	12440	871	12059	369	30145	1846	31991		3110	47	3157	9339	824	10134	8166	575	8741								
84	89	11480	804	11135	341	27838	1704	29542		2872	40	2912	8616	764	9380	10029	909	10939								
85	90	9720	680	9422	298	23559	1441	24995		2430	0	2430	7290	680	7970	10536	680	11216								
86	91	13824	960	13440	430	33599	2052	35651		3456	0	3456	10368	960	11328	12396	1004	13400								
87	92	12296	881	11919	365	29796	1825	31621		3074	0	3074	9222	861	10083	12881	1105	13966								
88	93	16160	1132	13672	480	39179	2399	41578		4042	0	4042	12120	1132	13252	9339	824	10134								
89	94	4840	301	4719	145	11796	723	12519		1217	0	1217	3651	301	3992	8616	764	9380								
90	95	12236	855	11841	362	29602	1912	31415		3056	0	3056	9162	855	10017	7290	680	7970								
91	96	5726	401	5548	170	13871	850	14721		1431	0	1431	4293	401	4694	10360	968	11328								
92		17571	2043	17032	1249	17032	1249	18280		4369	0	4369	13222	2043	16167	9222	861	10083								
93		18477	636	17910	270	17910	270	18179		4161	0	4161	14316	636	14952	12120	1132	13252								
94		7995	1030	7720	437	7720	437	8146		2523	0	2523	5472	1030	6502	3651	301	3992								
95		27890	2064	27042	975	27042	975	27956		5130	0	5130	22760	2064	24812	9162	855	10017	27042			2.6996				
96																4293	401	4694								
																13222	2043	16167								
																14316	636	14952								
																5472	1030	6502								
																22760	2064	24812								

Anticipated Returns in 1996
(based on the average R/S in 1992-1995)

	R/S Ratio			No. of Small		
	Small	Large	Total	Small	Large	Total
Mean	1.9972	0.0929	2.0902	18973	637	19719
Hi	2.6996	0.2192	2.9187	28573	1502	29875
Low	1.3509	0.0267	1.3776	10195	183	10378

Estimate of Precision

Observed - expected returns in 1992-1995

Comparison in 92-95 based on R/S ratio in 1992-1994

Recruit Year	Expected No.		Diff (Obs-exp)		% Difference	
	Small	large	Small	Large	Small	large
92	16892	612	40	636	0	51
93	21301	595	-3472	-326	-19	-121
94	8675	682	-725	-245	-9	-56
95	19432	520	11610	555	43	63
96	0					
			Mean		4	-16